SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

DECEMBER 1902.

GENERAL PHYSICS.

2193. *Earth's Density.* **F. Richarz** and **O. Krigar-Menzel.** (International Physical Congress at Paris, Report, 4. pp. 69–73, 1900–1901.)—The values of Δ obtained by the ordinary balance (5·49–5·51), by the torsion balance (5·527), and by the Wilsing pendulum (5·577), differ from one another too much, and it may be that they could be reconciled by a proper correction for magnetic forces acting on the masses used. [See also Abstract No. 1033 (1901).] **A. D.**

2194. *Seasonal Variations in Rate of a Clock.* **E. F. van de Sande Bakhuyzen.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 19–43, May, and pp. 187–210, June 28, 1902.)—Observations made on the mean time clock of the Leyden Observatory show that in the course of forty years its march has continually increased in regularity. The following figures represent the mean departures from a constant value for a part of the interval investigated :—

1862–1874	±	0·0291 sec.
1879–1896		0·0237 „
1899–1902		0·0215 „

The author next notes periodical departures from the true value practically represented by a sinusoidal curve with maxima corresponding with May 1 and November 1, the semi-amplitude being + 0·0466 sec. for the interval 1899–1901. These irregularities are mathematically identical with a half-monthly lag of the influence of temperature, as long as the monthly behaviour only is considered. But this fails to afford a physical interpretation, as experiments go to show that changes in temperature are felt immediately. Nor does the hypothesis that this may be due to the elasticity of the suspension-spring acting after a certain delay only, account for these phenomena. The author therefore suggests that the temperature of the different parts of the pendulum may be permanently different, the differences varying periodically with the season. In fact, this hypothesis would seem, generally, to account for the behaviour observed, though some phenomena would hardly agree with it. **A. G.**

2195. *Anomalous Elastic Properties of Glass.* **E. Wandersleb.** (Ann. d. Physik, 8. 2. pp. 367–371, May, 1902. From the Jenaer Dissertation.)—The anomalous change, with temperature, of Young's modulus for glass containing antimony, observed by Winkelmann, is measured for 11 glasses in the shape of bars 130 × 15 × 3–4 mm. Considerable differences present themselves between the stable or normal state (n) before warming, and the labile or accommodation state (a): The values, *e.g.*, of Y_n are 0·7–2 per cent. smaller than those of Y_a; Hooke's law holds, for the normal state, to near the breaking-point, but in the accommodation state a lagging increase of bend/stress takes place; and the accommodation state can be changed to the normal in a short time by the vibrations of certain tuning-forks of medium pitch. Glass containing boric acid and antimony behaves abnormally, *i.e.*, Y increases with temperature, whereas glass containing antimony, but free from boric acid, behaved normally. For the abnormal condition, the maximum Y is reached at about 200°, when Y is 2 per cent. greater than at 15°. Formulæ are given expressing the normal and abnormal changes of Y with temperature. G. E. A.

2196. *Theory of Cast-Iron Beams.* **E. V. Clark.** (Inst. Civil Engin., Proc. 149. pp. 3–31, 1902.)—It is well known that a cast-iron beam will bear a much greater load than that which, according to the ordinary theory, should produce fracture. The author shows that the great discrepancy is due to various approximations made in its application to such a material as cast iron. The ordinary theory is based on the assumptions that the material obeys Hooke's law to all intensities of stress, that its modulus of elasticity is the same for compressional as for tensional stresses, and that it is homogeneous. Cast iron fulfils none of these conditions, and the effect of non-compliance with each is to raise the strength of the beam to resist fracture. The object of the experiments is to determine the forms of the stress-strain curves for cast iron (of a particular quality); to deduce from these the position of the neutral axis and the ultimate moment of resistance of beams of certain types of cross-section; and to compare these calculated moments of resistance with the actual breaking moments (found by experiment) of similar beams of this quality of cast iron. Fifteen bars of cast iron were used, all cast from the same ladle; six were used for tension and compression tests, the remaining nine (three of rectangular section, three square-on-angle, three circular) for breaking under a bending load. In the tension and compression tests, the load was applied in steps of 2,000 lbs. per square inch of section, and was never removed after being applied. Strain was measured by a Kennedy extensometer, and in tension experiments readings were taken up to the point of fracture. In compression tests strain was read up to loads of 38,000 lbs. per square inch; no measurements of ultimate crushing stress were made. If y be the stress in lbs. per square inch, x the strain in hundredths per cent., then the results are (1) for tension, $y = 1690x - 24x^2$; (2) for compression, $y = 1690x - 7x^2$. The author then applies the equations of the tension and compression stress-strain curves to the theory of beams, obtaining expressions which give the position of the neutral axis and the modulus of resistance for beams of rectangular, square-on-angle, and circular sections. The result of using the more rigorous theory is to raise the strength of the beam to resist fracture by 41·1 per cent. for rectangular section, 57·3 per cent. for square-on-angle, and 48·9 per cent. for circular. The results of the bending tests (which were made in the usual manner, care being taken, however, that the load should never be removed after once being applied), show that with each type of beam over two-thirds of the discrepancy between the results of the ordinary theory and of experiment has been eliminated. It is to be remarked, in addition, that in the ordinary beam theory no account is taken of any stresses other than that of bending, and that severe local crushing stresses may add somewhat to the strength of the beam to resist fracture by bending. The paper is fully illustrated by curves and tables, and concludes with a summary of the equations deduced by various writers to represent the stress-strain curves of cast iron. W. S.

2197. *Transit Theodolite for Mining Engineers.* **H. D. Hoskold.** (Inst. Mining Engin., Trans. 22. pp. 536–557; Discussion, pp. 557–566, 1902.)—A detailed description is given, with drawings and illustrations, of a theodolite to be used for connecting underground workings to the surface, *vice versâ*, and for general surveying. The lower part of the telescope stand consists of a hollow cylinder, so that a sight can be taken in the direction of the nadir, and so down a shaft by means of a side eyepiece. The method of using the instrument in a shaft, and the necessary adjustments, are fully described. The discussion, after the paper, turned chiefly on the disturbance of plumb-lines in long shafts by air currents, and the author claimed that greater accuracy was to be obtained by using his instrument or an astronomical one than by the use of plumb-lines. G. E. A.

2198. *Tide Gauges in Northern Climates and Isolated Situations.* **W. B. Dawson.** (Inst. Civil Engin., Proc. 149. pp. 3–24, 1902.)—As the tides on the eastern coasts of Canada present a remarkable range, being exceptionally high in the Bay of Fundy, and almost inappreciable in some parts of the Gulf of St. Lawrence, eight principal stations have been fitted up for obtaining continuous tide records, and twenty-eight secondary stations chiefly for summer observations. Three of the principal stations, on Anticosti Island, on St. Paul Island in Cabot Strait, and at Forteau Bay, Labrador coast, Strait of Belle Isle, are accessible only by sea, and inaccessible during five months. The wooden gauge houses contain drum, pencil, clockwork, and tide pipe and sight gauge pipe, the two pipes being placed within an iron cylinder (old boiler) about 3 ft. in diameter; this cylinder is heated by lowering petroleum lamps with three duplex burners into it. The tide float is in the tide pipe, which has a diameter of 6 in.; the sight gauge similarly contains a float to which the scale is attached; both pipes communicate with the recess, into which the sea-water enters, by strainers. It is not desired to record wave motion, and long siphon feed-pipes are used in some instances. But the still problematical secondary undulations which have a period of 15 or 20 a minute, and are particularly pronounced at stations with very small tide ranges, are recorded. The clock works with a mainspring, and a spare clock is always kept; steel springs are liable to rust and to break, and gold hair-springs have proved the most reliable. The correct time is ascertained by the observer with the aid of a dipleidoscope, consisting essentially of two small mirrors at an angle to each other, which give two images of the sun; when the instrument is set truly in the meridian, these images coincide at apparent noon. H. B.

2199. *Seiche on Loch Trieg, Scotland.* (Nature, 66. pp. 162–163, June 12, 1902.)—While engaged in the survey of Loch Trieg on May 22, 1902, T. N. Johnston and J. Parsons observed a variation in the level of the lake of an amplitude of $\frac{9}{16}$ in., with a period of 9·5 minutes. The observations were made in the evening, and appear to have lasted only 40 minutes. The lake has a length of 6 miles, a width of $\frac{3}{4}$ mile, and a depth of 436 ft. This would be the first example of a seiche in Scotland, with the possible exception of a rise and fall of the water in Loch Tay in 1784. H. B.

2200. *Seismic and Magnetic Perturbations at Uccle, Belgium, May, 1902.* **E. Lagrange.** (Comptes Rendus, 134. pp. 1325–1327, June 2, 1902.)—Earthquake movements were recorded at Uccle (triple horizontal pendulum of Rebeur-Ehlert) on the first days of May, and stronger shocks on May 6 and 8. The interval between these latter two days was quiet: assuming that the tremors would travel with a speed limited to between 800 and 1,500 m./sec., the records cannot be ascribed to the eruption of Mont Pelée on May 8, at 7.50 a.m. The magnetic perturbations of Uccle and of Louvain do not coincide with the seismic records. H. B.

2201. *New Combination Telescope Mounting and Dome.* **D. P. Todd.** (Amer. Journ. Sci. 13. pp. 459–463, June, 1902.)—A new mounting is described which the author has designed in order to permit observers to use lenses of greater focal length than any now in existence. A large spherical framework is built up of steel girders, coated with oak and sheet copper, and adjusted as nearly as possible to a symmetrical figure. This is then floated in a special tank, faced with Portland cement, and having its surface carefully scraped to the exact figure. The water used for flotation is made part of a circulatory system, and warmed in winter to prevent freezing. The objective would then be attached to a portion of the surface of the sphere, and the eyepieces, photographic apparatus, &c., at the opposite end of the diameter. The observer is suspended inside the sphere, near the eyepiece, on a swinging platform with arrangements to keep the platform always horizontal in different positions of the sphere. The various motions which are necessary for following the celestial objects are obtained by rubber-faced gear wheels on the outer surface of the sphere, control over the direction being given by a massive polar axis which is put in connection with the dome when fixed on the star. Estimates are given of details for mounting a 60-in. objective on this principle. C. P. B.

2202. *Theory of Origin of Satellites.* **L. Picart.** (Comptes Rendus, 134. pp. 1409–1412, June 16, 1902.)—The paper deals with an attempt to examine whether the satellites of the various planets were originally disconnected with the main mass, being captured by gravitational attraction after some chance approach from space. It is found that the satellites of the Earth, Mars, Jupiter, Saturn, Uranus, and Neptune cannot have assumed their present orbits in this manner. C. P. B.

2203. *Influence of Magnitude on Star Chart Reduction.* **P. Henry.** (Comptes Rendus, 134. pp. 1483–1486, June 23, 1902.)—Examples are given of the changes in reduction scale produced by plates of varying exposure. The constants for correction are obtained by making duplicate exposures on each plate, the plate being very slightly displaced along a known direction between the two exposures. The two exposures are of different duration, giving star images of different diameters. C. P. B.

2204. *Constitution of Nebulæ.* **C. Nordmann.** (Comptes Rendus, 134. pp. 1282–1285, June 2, 1902.)—After stating the chief characteristics of the phenomena presented by nebulæ, the author summarises his reasons for supposing that the principal factor in producing the luminosity of these bodies is the influence of Hertzian waves from inter-stellar space. The degree of illumination produced will depend on the various states of pressure which exist in the different regions of the nebulous mass. C. P. B.

LIGHT.

2205. *A New Direct-Vision Prism.* **W. Volkmann.** (Ann. d. Physik, 8. 2. pp. 455–458, May, 1902.)—This is pentagonal in shape, and a ray, parallel to the base, entering an upper face, undergoes two internal reflections and passes out through the other upper face in the original direction, the angle of incidence being $(1+\sqrt{8\mu^2+1})/4\mu$. The prism has been patented in England, Germany, and Austria. A new prism for liquids is made by forming a trough, equilateral in section, with two interior reflecting surfaces. The ray passing through the liquid surface is twice reflected internally and again passes out through the surface. G. E. A.

2206. *Image of a Plane formed by a Prism.* **R. Straubel.** (Ann. d. Physik, 8. 1. pp. 63–80, April 29, 1902.)—The planes here referred to are assumed to be small compared with their distances from the prism. In a previous paper [see Abstract No. 243 (1899)] the author treated the question on the assumption that an infinitely small pencil of rays proceeding from a point at finite distance remains homocentric after traversing a prism with minimum deviation. In this case it appeared sufficient to consider a section of the pencil by the principal plane of the prism. The assumption, however, neglects the length of path in the prism. When this is considerable the emergent pencil is generally not homocentric, the astigmatic difference varying directly as the length of path in the prism. The angle between the primary and secondary image surfaces corresponding to one object plane depends on the ratio of these two quantities. The author therefore extends his former reasoning to a sagittal section. Object and image planes are supposed to be parallel to the edge of the prism, and the axis of the small pencils considered, to lie in a principal section of the prism. But the axes need not pass at minimum deviation, and the incident pencil may be already astigmatic if the focal lines are respectively parallel and perpendicular to the prism edge. The two following equations are obtained connecting the inclinations of object and image planes—

$$\tan\nu'.\frac{\cos r_2}{\cos i_2}-\tan\mu'.\frac{\cos r_1}{\cos i_1}=\frac{(n^2-1)\sin\alpha}{n\cos r_1\cos r_2}\cdot\frac{1-\sin i_1\sin i_2\cos(r_1-r_2)}{\cos^2 i_1\cos^2 i_2}$$

$$\tan\nu''\frac{\cos i_2}{\cos r_2}-\tan\mu''.\frac{\cos i_1}{\cos r_1}=\frac{(n^2-1)\sin\alpha}{n\cos r_1\cos r_2}.$$

Here the letters with a single dash refer to principal, those with a double dash to sagittal, sections. The μ's and ν's denote the obliquities of the object and image planes to the rays; i_1, r_1, r_2, i_2 the angles between the ray and the normals to the faces of the prism in order, α is the angle of the prism, and n the index.

The following are among the consequences deduced: (1) In each section the obliquities of object and image are generally different, but for every inclination of the ray a pair of conjugate planes can be found whose obliquities are in a given ratio. The corresponding case for minimum deviation is when the planes are *parallel* to the pencils. (2) An orthogonal object never gives an orthogonal image. Several pages are occupied by discussion of the boundary conditions ($\tan\mu''=0$ and $\tan\nu''=0$); and curves with ν', ν'' as ordinates and i as abscissa are given, showing how the inclination of the image varies with the angles of incidence. The possibility of homocentric and erect representation of an inclined object plane is discussed ($\mu' = \mu''$, and $\tan \nu' = 0 = \tan \nu''$), and it is found that small obliquities of the object can only be corrected by prisms of small angle and index nearly $= 2$. A. E.

2207. *Focal Lines in Isotropic Media.* **H. Bouasse.** (Journ. de Physique, 1. pp. 201–207, April, 1902.)—A proof is given of Sturm's theorem of focal lines, using a geometrical surface and its normals instead of rays of light. It is shown that, if a surface of revolution be taken, the pencil of normals to any element of the surface passes rigorously through an element of the axis of the surface, and that this element of the axis is not a focal line. G. E. A.

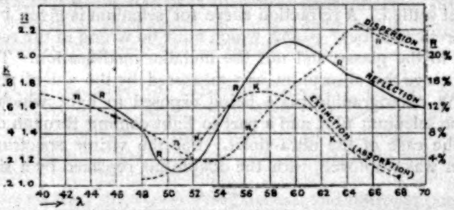
2208. *Optical Demonstrations by means of a naturally Curved Surface.* **J. J. Taudin Chabot.** (Phys. Zeitschr. 3. pp. 331–332, May 1, 1902.)—A glass cylinder containing mercury is rotated on a whirl-table, and various simple optical experiments are performed by hanging an electric lamp above the revolving mercury and interposing smoke to show the path of the rays. A fluorescent liquid can be substituted for the mercury to exhibit refraction effects. G. E. A.

2209. *Surface Colour.* **R. W. Wood.** (Phys. Rev. 14. pp. 315–318, May–June, 1902.)—Optical text-books contain misleading statements regarding the phenomenon of surface colour exhibited by certain strongly absorbing media; for instance, that these substances reflect most strongly those colours which they most strongly absorb. One of the more recent advanced books refers the phenomenon to total reflection, due to the index being less than unity. As a matter of fact it falls below unity only in the case of a very few substances. Moreover the selective reflection occurs at normal incidence. The statement that the most strongly reflected light corresponds to the light absorbed is erroneous. Take cyanine as an example. The centre of the absorption band is very near the D lines, but the surface colour is not yellow but a deep plum colour, not so very unlike the transmitted light. On examining the spectrum of the reflected light we find a very dark band in the green, the centre being near wave-length 0·50; while the distribution of intensity in the rest of the spectrum is not very different from what it would be in the case of reflection from glass. This shows that the peculiar colour of the dye is not so much due to a very powerful reflection of certain waves as to its almost complete refusal to reflect certain other waves. Remembering that reflecting power depends on index as well as on the coefficient of absorption, this behaviour can easily be explained. The intensity of the light reflected at normal incidence is given by the formula—

$$R = \frac{n^2 + n^2k^2 + 1 - 2n}{n^2 + n^2k^2 + 1 + 2n}$$

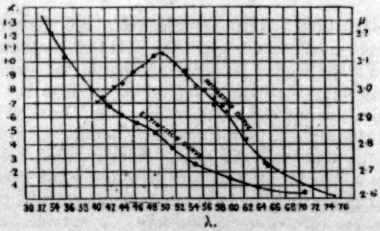
[k being the coefficient of absorption]. In absorbing media the index varies much more than in transparent substances, consequently greater variation in reflecting power is to be expected, apart from the fact that the absorption influences R directly. Taking Pflüger's values of n and k for cyanine, the author has calculated the percentages reflected in the cases of the different wave-length.

The accompanying curve was thus obtained; it shows clearly the cause of the peculiar surface colour of the dye. Starting from the red end, we find that the intensity of the reflected light first increases owing to the joint increase in *n* and *k*. The increase continues after *n* begins to decrease owing to continued increase of *k*. After reaching a maximum at $\lambda = 0{\cdot}59$, it turns and descends rapidly to a minimum at $\lambda = 0{\cdot}50$, where the values of both *n* and *k* are very small. Beyond this point the rise is due to increase in *n*, since *k* is practically zero in this region. Scarcely 2 per cent. of the incident light is reflected at $\lambda = 0{\cdot}50$, which explains the dark band in the green alluded to above. An excellent way of showing the variable reflecting power of a film of cyanine is to compare it with glass in different parts of the spectrum. A little of the melted dye is pressed between two plates of hot glass, which are separated when cold. A spot is selected where the film has a good surface, and this spot is left on the glass, the rest being cleaned off. The plate is then held in a spectrum. In some regions of the spectrum the cyanine reflects more strongly than the glass, while at $\lambda 0{\cdot}50$ the film appears as a black spot on the blue field reflected by the glass. It is interesting to note the difference in surface colour of the cyanine when the reflection takes place at the surface in contact with the glass. A convenient way of showing the yellowish-green colour in this case is to press out a film of the molten dye on one surface of a prism of 8° or 10° angle. The light reflected from the first glass surface is thus thrown out of the way. A suitable prism can be made in half an hour by grinding down a piece of thick plate window glass. A. E.



2210. *Absorption, Dispersion, and Surface Colour of Selenium.* **R. W. Wood.** (Phil. Mag. 3. pp. 607–622, June, 1902. Paper read before the Physical Society, Feb. 28, 1902.)—The dispersion curves of substances with absorption bands in the visible or infra-red spectrum have been much studied, but scarcely any work has been done on those whose absorption begins in the visible region and extends far into the ultra-violet. The author selected amorphous selenium as a type of these media. He first studied its dispersion by direct spectrometer measurements with prisms of the substance. Selenium is much more transparent than cyanine, and prisms of 4° or 5° could be employed, which were made by squeezing small pieces, heated to fluidity, between two glass plates. It was found impossible to construct prisms of small enough angle to make determinations for smaller wave-length than $0{\cdot}61\,\mu$ feasible. The curve was therefore followed further towards the violet by means of the interferometer in the manner described in previous papers on cyanine and carbon. Uniform selenium films on glass plates were employed in the first place, but in the blue only exceedingly thin ones let any light through. Wedge-shaped films were therefore adopted, which were obtained by shielding the plate during the deposition with a strip of mica at one side. Curved fringes were thus obtained which would allow the displacement for any wave-length to be measured for the maximum thickness capable of transmitting the light. Another advantage of the wedge-shaped films is that the displaced fringes can be identified with the undisplaced. The values of the indices obtained in the red by means of the prisms were taken as a basis for the calculations from the interferometer results. The dispersion curve obtained is shown in the figure ("refraction curve"). The turning-point is at λ·50, where the index reaches the value 3·13, the highest value ever found for any substance. The continued rise of the dispersion curve after entrance into the region of the absorption band (near the D line) is worthy of notice, for usually the curve falls abruptly as soon as the band is entered. Whether the displacement of interference-fringes gives a true measure of index in the case of films whose thickness is less than the wave-length of light, is a question not yet settled. A refraction curve for selenium is given by Ketteler in his "Theoretical Optics," p. 552, which must be wrong in the red and orange if it refers to the glassy, and not the metallic modification. To obtain the extinction curve the absorption was measured by the aid of photography, a part of the photographic plate being exposed to light which had passed through the selenium film, and a part to light coming through clear glass, or quartz in the case of the ultra-violet. For the visible spectrum a spectrophotometer was employed, with the double slit replaced by a single slit, the photographic plate being mounted behind the ocular slit. For the ultraviolet a concave grating by Thorp was used instead. It was made by mounting one of his celluloid replicas of a Rowland grating on a concave lens, the celluloid film being silvered. On somewhat reducing the aperture it gave surprisingly sharp images. The extinction curve is not to be taken as very accurate, but the fact was fully established that the curve is still rising rapidly at λ·22, where the coefficient is as high as in metals. A possible turning-point might, however, be masked by a high reflection coefficient. It is probable that we have to deal, not with a single absorption band, but with a series of overlapping bands. The infra-red transmission was examined down to 2·3 μ with a very sensitive bolometer, and no absorption bands were found. A search for traces of selective absorption in the ultra-violet had negative results. Selenium shows a strong surface-colour if the incidence is near the polarising angle, and the reflected light examined through a nicol turned to extinguish it as much as possible. The colour ranges from greenish-white through blue to deep violet. At present the author is investigating nitroso-dimethyl aniline, a substance of remarkable behaviour. It crystallises in green laminæ, which melt at 85°, and can be formed into fluid prisms, which become opaque when solid. Pressed into a thin film it seems nearly as transparent as pale yellow glass, but with the spectroscope the blue end of the spectrum is seen cut off almost as sharply as by a screen. The author was assisted in the above researches by A. H. Pfund. A. E.

Fig 4



2211. *Luminous Sensation a Function of the Time.* **A. Broca** and **D. Sulzer.** (Comptes Rendus, 134. pp. 831–834, April 14, 1902.)—A luminous sensation passes through a maximum which is more quickly reached the brighter the light is (say from 0·04 to 0·2 seconds), and falls to a permanent value which is also more quickly reached the brighter the light is (say from 1·1 to 2·5 seconds). The ratio between the maximum and the permanent value is greater the brighter the light is (say from 5·5 to 1·12). A. D.

2212. *The Majorana Effect.* **W. Voigt.** (Accad. Lincei, Atti, 11. pp. 505–507, June 15, 1902.)—Majorana has described [See Abstract No. 1844 (1902)] a magneto-optic phenomenon analogous to the acquisition of double-refracting properties by a dielectric under electric stress. Voigt here gives a theoretical explanation on lines similar to those which he has followed in dealing with Kerr's electrostatic effect. W. S.

2213. *Magnetic Rotation in Liquefied Gases, II.* **L. H. Siertsema.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 250–255, June 28, 1902.)—The author, continuing his researches in magnetic rotation with an improved apparatus, finds the constant of magnetic rotation in the case of liquefied CH_3Cl under atmospheric pressure, and for sodium light, to be 0′·01372, the rotatory dispersion being normal, and differing but little from the one observed with gases and water. [See also Abstract No. 842 (1902).] A. G.

2214. *The Band Spectrum of Nitrogen.* **G. Berndt.** (Ann. d. Physik, 7. 4. pp. 946–948, April 8, 1902. Paper read before the Physikalischen Institut zu Halle.)—In the band spectrum of nitrogen obtained with the oscillating spark discharge, and in that from the negative pole in Geissler tubes, the group arrangement is the same. The wave-lengths in both agree together. The distribution of intensity, on the other hand, is a completely different one. Hence it follows that of the bands from the Geissler tube by far the most are not resolved with small dispersion, whilst those obtained from the oscillating spark discharge are split up into single lines with comparative ease. J. J. S.

2215. *New Heads to Cyanogen Bands.* **C. C. Hutchins.** (Astrophys. Journ. 15. pp. 310–312, June, 1902.)—The author claims to have discovered new heads to bands in the cyanogen spectrum at $\lambda = 3914{\cdot}47$, $\lambda = 4278{\cdot}50$, and also of a new head to the band at $\lambda = 4606$, but of this he is doubtful. The bands were obtained with metallic poles with arc and spark. The fact that these heads belong to cyanogen appears rather doubtful, especially as moistening the poles with oil has no effect on them, while the known cyanogen bands are greatly increased. Possibly they are due to Basquin's hydrogen-metallic spectra. [See Abstract No. 677 (1902).] E. C. C. B.

2216. *Transparency of Matter to Röntgen Rays.* **L. Benoist.** (Soc. Franç. Phys., Séances, 3. pp. 204–219, 1901.)—From his investigations on the varying degrees of transparency towards Röntgen rays of different bodies, the author is led to state certain definite laws. He found previously that the *specific opacity*, or the absorbing power of unit mass, in general increased rapidly with the density, and depended on the state of the Röntgen-ray tube employed, that is, on the nature of the rays given out. In the investigation here described the author made use of the fluorescent screen method.

The following are the laws of the phenomena which he has arrived at: (1) The specific opacity of a body for a given quality of Röntgen rays and for a determined standard thickness is independent of the physical state of the body. Thus the same value holds for water and for ice, for solid iodine and for iodine vapour. This statement differs from the results arrived at by other observers whose observations the author criticises. The law stated applies to variations due to changes of temperature, and to crystalline and amorphous states of the same substance. (2) The specific opacity of a body is independent of the atomic or molecular mode of grouping, *i.e.*, of allotropy in simple bodies or polymeric modifications in compounds. The yellow and red varieties of phosphorus have the same equivalent of transparency. (3) The specific opacity is independent of the state of freedom or of combination of the atoms. This may be stated in the following equation:—

$$\frac{M}{E} = \Sigma \frac{m}{e},$$

where M is the total mass of the compound or mixture, E its equivalent of transparency, m the mass of one of the contained elements, and e its equivalent of transparency. (4) The specific opacity of simple bodies, measured under well-defined conditions, is a determinate function of their atomic weights and generally increases with the atomic weight. This law the author expresses by means of a curve which is given in his paper, its equation being of the form—

$$E = A + \frac{B}{P} + \frac{C}{P^2}$$

The specific opacity for Röntgen rays is considered to constitute a new additive property of matter, like mass, atomic weight, &c. Each curve of equal transparency qualifies in a precise manner a definite group of Röntgen rays, and these may be put under the heads of Röntgen-rays, secondary rays, tertiary rays, rays of uranium, radium, &c. The Röntgen-ray tubes may also be classified. The author suggests that the Röntgen-ray constants may be used for the determination and verification of atomic weights, and that the varying transparency for Röntgen rays may also be used to recognise certain mixtures and to detect frauds and adulterations in various alimentary or industrial products. J. J. S.

2217. *Stereoscopic Radiology.* **T. Guilloz.** (Comptes Rendus, 134. pp. 1303–1305, June 2, 1902.)—When the conditions are truly stereoscopic, there is a remarkable power of dealing with the distances of the different parts of the image, and a measuring rectangular network of wire can be brought into coincidence with any plane of the image. When not, there are serious illusions; described. A. D.

REFERENCE.

2218. *Finsen's Lupus Treatment.* **Kattenbracker.** (Röntgen Ray, Archives, 6. pp. 89–92, April, 1902.)—An account is given of Kjeldsen's iron-electrode arc lamp for lupus, and of bactericidal experiments with it at Aufrecht's Institute, Berlin. A. D.

HEAT.

2219. *New Form of Recording Apparatus for a Roberts-Austen Electrical Pyrometer.* **E. A. Lewis.** (Soc. Chem. Ind., Journ. 21. pp. 844–845; Discussion, p. 845, June 30, 1902.)—The ordinary recording drum turns by clockwork once in 6, 12, or 24 hours. The author has designed a smaller drum, which is connected with a pulley, round which passes a cord attached to a float; as the float falls it turns the drum once in from five minutes to an hour, according to the adjustment. This smaller drum is suitable for recording the cooling curves of small quantities of metals cooling in a crucible.
D. H. J.

2220. *Liquefaction of Air.* **G. Claude.** (Comptes Rendus, 134. pp. 1568–1570, June 30, 1902.)—The author uses a modified Linde apparatus, with the important difference that the escaping gas is made to perform external work which is absorbed by a dynamo. The paper describes the modifications in the apparatus since September, 1900. In the latest form the machine works at a pressure of 28 to 30 atmospheres, developes a useful power of 6–7 h.p., and furnishes 20 litres per hour of liquid air. R. S. W.

2221. *Melting-point of Manganese.* **W. C. Heraeus.** (Zeitschr. Elektrochem. 8. pp. 185–187, April 3, 1902.)—The melting-point of manganese is difficult to determine accurately, owing to the ease with which the metal combines with oxygen and other gases at high temperatures. Two methods, used in determining the melting-points of metals by Professor Holborn, of Charlottenburg, were found to be unsuitable on account of the necessity of excluding oxygen completely, and the difficulty of fusing a piece of the metal on to the ends of a Le Chatelier thermocouple. The author used his new electric furnace [see Abstract No. 2295 (1902)]. The requisite temperature is obtained by varying the resistance in circuit, and can be kept very constant. Hydrogen, dried and carefully freed from any trace of oxygen by passing through alkaline pyrogallate, was found to be the only gas not attacked by melting manganese; carbon dioxide was decomposed, and nitrogen combined with the metal at 1,210° C. with production of flame. Further difficulties were experienced in choosing a substance on which to melt the manganese; porcelain, lime, and electrically melted magnesia were useless, and finally pure alumina was employed. The following temperatures were obtained for the melting-point of manganese (99 per cent. Mn): 1,240°, 1,245°, 1,240°, 1,265°, 1,240°, 1,250° C. The fourth determination is probably too high, owing to the presence of moisture. W. C. B.

2222. *Vapour Pressures and Boiling-points of Mixed Liquids.* **S. Young.** (Chem. Soc., Journ. 81. and 82. pp. 768–776, June, 1902.)—The author considers that a decision might be formed as to what constitutes the normal behaviour on distillation of a mixture of liquids which are miscible in all proportions, by studying closely related substances like chlorobenzene and bromobenzene. He has already shown that many simple physical relations exist between these bodies, for which the critical points are the same and for

which there is a constant ratio of the boiling-points on the absolute scale; he now shows that there is no heat or volume change on mixing. The boiling-points of several mixtures were determined at pressures varying from 685 mm. to 789 mm., and the results were found to be in accurate accordance with the law which van der Waals (modifying a formula of Guthrie's) proposed for the case of two liquids having the same critical point and according with the equation $a_{1.2} = \sqrt{a_1 . a_2}$ (Galitzine, Berthelot), where $a_{1.2}$ represents the attraction of the unlike, a_1 and a_2 of the like molecules. Van der Waals' law may be stated thus: The relation between the vapour pressures and the molecular composition of mixtures of such substances is represented by a straight line, or $P = p . P_A + (100 - p) P_B/100$, where P, P_A, and P_B are the vapour pressures of the mixture and of the two pure components A and B, at the same temperature, and p is the molecular percentage of one of them.
D. H. J.

2223. *Corrected Specific Heats, and Latent Heats of Vaporisation for some Organic Substances of High Boiling-point.* **W. Louguinine.** (Annal. Chim. Phys. 26. pp. 228–247, June, 1902.)—The author, working with his perfected arrangement, has made further redeterminations of specific and latent heats; incidentally he has determined the vapour densities of some of the substances at temperatures near the boiling-point. The results are given in the following table:—

Substance.	Sp. Heat.	Lat. Heat.
Methyl hexylacetone	0·5723	71·11
Ethylene glycol	0·6808	190·90
Benzyl alcohol	0·5579	98·46
Benzaldehyde	0·4453	86·55
Diethyl oxalate	0·4818	67·58

The specific heats given are mean values for temperatures between 20° (about) and a temperature not higher in any case than 195°.

An application of Trouton's ratio to the data for the above substances proves the absence of polymerisation in the liquid state in all cases except one (ethylene glycol).
D. H. J.

2224. *Theory of the Critical Phenomena and of Evaporation.* **J. Traube.** (Ann d. Physik, 8. 2. pp. 267–311, May, 1902.) [See also Abstract No. 1445 (1900).]—Attention is called to certain facts which cannot be explained by the simple theory of the critical phenomena advanced by Andrews. It appears now to be fully established that in a large number of cases the liquid and vapour layers do not at once become identical when the critical temperature is reached; at this temperature the two layers become completely miscible, and if the tube containing the substance be frequently shaken nothing abnormal can be noticed; but if the tube be kept at rest the upper and lower layers only gradually become identical when the critical temperature is reached, especially if the temperature is not raised much above the critical. The gradual inter-diffusion of the two layers has been noticed by a large number of observers, including the author, whilst Hannay and Hogarth have rendered it easily visible by dissolving eosin, and Cailletet and Colardeau by dissolving iodine in the liquid. Differences of refractive index, appearing abruptly at what was previously the boundary of the liquid and vapour layers, have been noticed by Ramay, and have been measured by Galitzine, who found the difference between the refractive index of the two phases of ethyl ether to be six times as great above as below the critical temperatures. Ramsay, Battelli, and de Heen have shown that unless the critical temperature has been considerably exceeded or the heating prolonged for more than half an hour, condensation occurs only in that part of the tube which was previously occupied by liquid, and Guye has found that in the case of carbon dioxide cooling from above the critical temperature equilibrium between the two phases is not established for more than a week, and that during this time the meniscus is gradually displaced through several centimetres. Differences in density have been observed by Cailletet and Colardeau by means of an O-tube containing carbon dioxide and sulphuric acid, whilst de Heen and Dwelshanvers-Dery have shown that above the critical temperature the density of the gas depends not only on the pressure and temperature, but also on its previous history, *i.e.*, whether it was formed from the liquid or vapour layer; this difference of density may amount in the case of carbon dioxide to as great a ratio as 1 : 2·16; the difference of density persists considerably above the critical temperature of carbon dioxide (31°), and it is only at 60° that the gas begins to possess a determinate density.

To explain these phenomena the author assumes that two kinds of molecules exist—"gasogenic" and "liquidogenic"—that the liquid contains a proportion of gasogenic molecules gradually increasing from 0 at the absolute zero until, at the "absolute gas-point," which may be several degrees above the critical temperature, "liquidogenic" molecules can no longer exist, and the substance exists wholly in the "gasogenic" form. Similarly it is supposed that the saturated vapour contains a steadily increasing proportion of "liquidogenic" molecules until at the critical temperature the proportions become identical in the two layers and the meniscus disappears. It is supposed, however, that equilibrium between the two kinds of molecules is only established after an interval of time, and the proportions in the two layers would only slowly become identical. The critical temperature is then a stable "triple-point," and corresponds exactly with the critical temperature at which liquids such as water and phenol become completely miscible. The absolute volume b of a gram molecule of the gas can be deduced from van der Waals' equation $(p + \frac{a}{v^2})(v - b) = RT$, whilst the minimum volume of a gram molecule of liquid at the absolute zero can also be calculated from the density curves of liquid and saturated vapour [see Abstract No. 1439 (1900)]. From these values the conclusion is drawn that the absolute volume of the gasogenic molecules is double that of the liquidogenic molecules—a result in accordance with the observations of de Heen and Galitzine on the density and refractive index of the two layers of the substance which persist above the critical temperature. In the case of monatomic mercury, however, the b values are almost absolutely steady from the lowest temperatures up to 350°, and here, perhaps, only one kind of molecule exists. In the case of most liquids the proportion of gasogenic molecules is calculated to be about 9 per cent. at the ordinary boiling-point. Calculations are also made of the heat required for converting one gram molecule of substance from the liquidogenic to the gasogenic condition; the values range from 4,500 to 7,200 cal.

From the standpoint of his theory the author seeks to deduce a new view of the osmotic phenomena, by assuming that each molecule of a non-electrolyte combines with a single gasogenic molecule, whilst binary electrolytes are assumed to combine with two molecules and ternary electrolytes with three molecules. In this way he accounts for the observed lowering of vapour pressure, but no attempt is made to explain the accompanying electrical phenomena. T. M. L.

2225. *Correlation of Latent Heat of Evaporation with Vapour Density.* **W. Kurbatoff.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 3a. pp. 250–287, 1902.)—The author describes a method of determining the latent heat of evaporation in the case of readily gelatinising substances. This method is applied to hydrochloric aniline with varying pressures; the total thermic capacity and the thermic capacity of the liquid substance are also measured, and a method of eliminating the influence of the time of transport from the heater to the calorimeter is suggested. Hydrochloric aniline is found to be totally dissociated at 244° and 760 mm., whereas, at a temperature 15° below, 10 per cent. of the chlorhydrate is undecomposed, the liquid studied thus being capable of conserving undecomposed molecules in the vapour in a manner analogous to ammonia. It results from the theory as well as from the experimental data, that Trouton's law is common to all liquids. The true molecular weight of the vapours is determined, the values found being either normal or too high, the latter pointing to a dissociation of the body taking place. The dissociation corresponding to the liquid phase proves to be very small, and Linebarger's constant is found not to be true. A. G.

2226. *Calorimetric Determination of Curve of Fusion.* **A. Wyscheslawzew.** (Jurn. Russk. Fisik. Chimičesk, Obščestva, 34. 3b. pp. 41–48, 1902.) —The author describes a modification of de Visser's method of determining the form of the curve of fusion by calorimetrical measurements (Zeitschr. Phys. Chem. IX., p. 767, 1892), this modification requiring much smaller quantities of the substance than the original device. The values of the quotient $\Delta v/\Delta r$, where v is the volume and r the heat of fusion, are determined for naphthaline, phenol, ortho-nitrophenol, ortho-cresol, and trimethyl-carbyl; and the values of the differential quotient dt/dp, as calculated from the same by multiplying by ET, are compared with those found by direct experiment for the three former, the agreement being a most satisfactory one. A. G.

2227. *van der Waals' ψ-Surface, III.* **J. E. Verschaffelt.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 255–269, June, 1902.)—The author studies the state-equation and the ψ-surface in the immediate neighbourhood of the critical state for binary mixtures with small percentages of one of the components. The p, v, T diagram is first given for a homogeneous substance; the system of isothermals of a mixture such as defined above is next found by performing an infinitely small parallel displacement and expansion of the one of the pure substance, the critical point being shifted on to the critical point of the undecomposed mixture. Van der Waals' ψ-surface is subsequently considered, the coexisting phases, the plait-point, the projection of the connodal line on the x, v-surface, and the critical point of contact being the elements investigated more especially. [See also Abstract No. 1745 (1902).] A. G.

2228. *Evaluation of van der Waals' Constants, II.* **P. A. Guye** and **L. Friderich.** (Archives des Sciences, 13. pp. 559-568, June, 1902.)—In continuation of a former paper [see Abstract No. 2006 (1900)], the values of a and b for 22 more substances are calculated from the experimental determinations of the critical temperature and pressure. Obvious modes of estimating the really varying values of a and b with temperature are also given, and for isopentane the following values, referred to the gram-molecule, are calculated; the values found by the other method being $a = 1{\cdot}838 \times 10^7$, $b = 143{\cdot}6$.

$t°$ C.	Liquid.		Vapour.	
	a	b	a	b
10	$1{\cdot}130 \times 10^7$	87·6	$5{\cdot}878 \times 10^7$	1260
30	1·154	88·2	4·063	415
50	1·187	89·1	3·674	428

R. E. B.

2229. *Thermal Properties of Carbon Dioxide and of Ethane.* **J. P. Kuenen** and **W. G. Robson.** (Phil. Mag. 3. pp. 622–630, June, 1902.)—From their low-temperature determinations of vapour pressure [see Abstract No. 1079 (1902)], the authors conclude that for carbon dioxide (1) the law of corresponding states is obeyed within the same limits as by the non-associating substances; (2) the density diameter, which is practically straight for temperatures above 0°, is for lower temperatures slightly convex to the temperature-axis; (3) the latent heat of vaporisation has no maximum value as according to Mathias's formula; (4) at the triple point (— 56·24° C. under pressure 5·1 atmos.) the specific volumes of the vapour, liquid, and solid may be taken as 74, 0·850, 0·676, the latent heats of vaporisation, fusion, and sublimation as 86·1, 43·8, 129·9, and the corresponding values of dp/dt, 0·224, 47·9, 0·337; (5) the latent heat of sublimation increases as the temperature rises. For ethane estimations of the specific volumes and latent heats of vaporisation are given, but the data are more uncertain than for CO_2.

R. E. B.

2230. *Rupture and Displacement of Equilibrium.* **Jouguet.** (Comptes Rendus, 134. pp. 1418–1420, June 16, 1902.)—The conditions of equilibrium under a series of circumstances of a system without viscosity, and of which we may neglect the inertia, are here deduced, especially for adiabatic modifications. R. E. B.

2231. *Certain Laws of Radiation.* **E. Kohl.** (Ann. d. Physik, 8. 3. pp. 575–587, June, 1902.)—The writer proposes to prove Stefan's law of radiation, and the Bartoli-Boltzmann law, as deductions from the results obtained by Wien as to radiation from a moving surface. Following Wien in principle, he supposes a cylinder of length $a - x$, its curved surface and one of its flat ends being perfectly reflecting and impervious to heat, while the other flat end is filled by a body of very small thickness at temperature θ, which radiates only into the cylindrical space. The total radiation energy within the cylinder is proportional to the length $(a - x)$ of the cylinder, and to a function, $\psi(\theta)$, of θ. It may be divided into separate portions according to the wave-length. The assumption is fundamental that the density of radiation, and therefore also the energy, depends only on the temperature of the radiating surface, and not on its physical nature. It is, therefore, the same as if the radiating surface were a perfectly black body. The radiating surface being moved slowly so as to diminish $(a - x)$ by dx, it is shown by Wien's method that p, the frequency of vibration for any wave, undergoes change, becoming $p\,dx/3(a - x)$. Also that θ and the energy E change according to the formula $dE/d\theta \,.\, d\theta = E\,dx/3(a - x)$. This increase of energy implies a pressure on the radiating surface in accordance with the law of Bartoli and Boltzmann, which thus appears as a deduction from Wien's work. The writer then proceeds to thermodynamical considerations. We have, by the second law, the relation $(A + Q)\theta' - \theta/\theta' = A$, in which A is a quantity of work converted by the usual reversible process into heat at temperature θ', while a quantity of heat Q is raised from temperature θ to θ'. Applying this formula to the preceding problem, he obtains the relation $a - z = a\theta_0^3/\theta^3$, which gives for the energy $\psi(\theta) = C\theta^4$ where C is a constant. This expresses Stefan's law, already established on theoretical grounds by Boltzmann and Wien, and recently by Larmor [see Abstract No. 503 (1901)]. The investigation has proceeded on the assumption that the processes are reversible, which would not be the case if the radiating surface absorbs heat. This was the reason for making it infinitely thin as stated above. It is shown that it is sufficient for the purpose to assume that heat is supplied from without to the radiating surface so as to maintain it in thermal equilibrium with the cylindrical space. From the equations already obtained between p and θ, the writer further deduces the most general form of the relation between density of energy and frequency p, which satisfies Stefan's law in the form—

$$\psi(p\theta)dp = Cp^3\phi\left(b\frac{b}{\theta}\right)dp$$

This is subject to the unknown function ϕ. From the last equation the author deduces Wien's law for the relation between θ and the maximum intensity. It is pointed out that the investigation also rests on Boltzmann's assumption that the radiation can be resolved into three mutually perpendicular components. The concluding section deals with the consequences that would follow if the alteration of p due to the motion of the radiating surface had a different form—if, instead of p becoming $p\left\{1 + dx/3(a - x)\right\}$, it became $p\left\{1 + m\,dx/(a - x)\right\}$, where m is a constant. S. H. B.

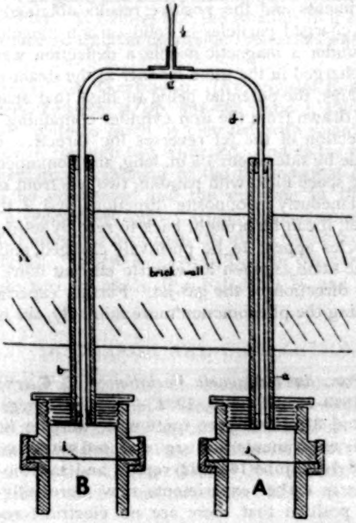
REFERENCES.

2232. *Monatomic Gases.* **D. Berthelot.** (Soc. Franç. Phys., Séances, 3. pp. 195–198, 1901.)—This is the complete paper referred to in an abridged form in Abstract No. 1655 (1901). R. E. B.

2233. *Denizot's Deduction of the Second Law of Thermodynamics.* **W. Voigt.** (Ann. d. Physik, 8. 2. pp. 472–473, May, 1902.)—The fallacy of Denizot's reasoning [see Abstract No. 1333 (1902)] is here pointed out, as already indicated in the Abstract. R. E. B.

SOUND.

2234. *Transmission of Sound through Solid Walls.* **F. L. Tufts.** (Amer. Journ. Sci. 13. pp. 449–454, June, 1902.)—Experiments are described upon the transmission of sound through materials impervious to air, and it is found that such transmission takes place, not as an elastic wave, but as a to-and-fro vibration of the wall itself. The apparatus used is shown in the diagram. In the 8-in. brick wall is placed the bifurcated system of piping shown. The observer places his ear at *h*, and the sound-wave (caused by dropping a metal ball upon a pine board) strikes the discs shown at A and B. By alternately opening and closing the rubber tubes *c* and *d*, the observer can easily ascertain which of the two discs transmits the louder sound. Discs of lead, pine, brass, cardboard were experimented upon, their rigidities being also measured. It is found that in all cases the amount of sound transmitted as an elastic wave is negligible in comparison with that due to the vibration of the disc as a whole. The effect of mass is small in comparison with that of rigidity. J. W. P.



REFERENCE.

2235. *Sounding-Flames and Flame-Telephony.* **H. T. Simon** and **M. Reich.** (Phys. Zeitschr. 3. pp. 278–285 ; Discussion, pp. 285–286, April 1, 1902. Paper read before the 73rd Naturforscherversammlung at Hamburg.)—A historical *résumé* of the whole subject of sounding arcs and photo-telephony. A. D.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

2236. *Production of a Magnetic Field by a Flight of Charged Particles.* **R. W. Wood.** (Phil. Mag. 3. p. 659, June, 1902.)—In Rowland's experiment on electric convection, and in the later modifications of it, centrifugal force places an upper limit upon the attainable velocity of the moving charge. To avoid this the author has abandoned the rotating disc, and uses a flight of charged particles. The present paper is merely a note explaining the preliminary experiments and the positive results obtained from them. By driving a cloud of charged particles of solid carbon dioxide through a long glass tube placed under a magnetic needle, a deflection was obtained. The particles become charged in the same manner as the steam-jet in Armstrong's hydroelectric machine, the potential being so high that sparks over a centimetre long can be drawn from the iron cylinder containing the liquefied gas. Reversing the direction of the jet reverses the direction of the deflection. With two tubes side by side, about 1·5 m. long, and contained in a larger tube, with the remaining space filled with paraffin, two jets from separate cylinders can be sent simultaneously in opposite directions, and if the needle is first deflected by one jet, it can be brought back to zero by setting the other jet in action. The particles appear to be positively charged, and the direction of the deflection is the same as when an electric current flows from the carbon to the zinc in the direction of the gas-jet. Further experiments, going into details and examining the phenomenon more minutely, are now in progress.

W. C. H.

2237. *Electric Force due to Magnetic Variations.* **E. Carvallo.** (Comptes Rendus, 134. pp. 1349–1352, June 9, 1902.)—Crémieu's negative results [see Abstracts Nos. 56 and 316 (1902)] are quite what were to be expected from the conditions of his experiments, and are in accord with Maxwell's principles. **Crémieu** (pp. 1423–1425, June 16, 1902) replies and says he had anticipated M. Carvallo's points in earlier experiments, now more fully described; and he adheres to the position that there are no electric forces generated in dielectrics by magnetic variations. A. D.

2238. *Statistical Electro-Mechanics.* **van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 79–88, May, and pp. 243–250, June, 1902.)—In a recent work, Gibbs records the results of some considerations relative to a science, called "Statistical Mechanics," the laws of which will govern the behaviour of a great number of analogous systems independent of one another as to their motion. These laws being, however, limited to systems made up of ponderable matter, the author here endeavours to apply similar considerations to electromagnetic systems, with a view to obtaining a means of completing our knowledge of the radiation phenomena from a thermodynamic point of view. After discussing the very limited value of Gibbs' "canonic systems," the author goes on to show that the so-called "law of conservation of phase density" is valid in the case of electromagnetic systems as well. As the motion of canonic systems cannot be applied to ethereal systems, a similar mode of distribution, termed quasi-canonical distribution, is considered, and it is shown that this affords a means of determining the distribution of energy over the different times of vibration. As, however, the state of a space filled up with "black" radiation is not represented by the equations derived, it proves impossible to deduce, on Wien's law of displacement, a complete spectral formula for "black" radiation. A. G.

2239. *Unipolar Induction.* **E. Hoppe.** (Ann. d. Physik, 8. 3. pp. 663–674, June, 1902.)—The author describes a method used by him for observing the so-called unipolar induction. The conductor under observation contained in its circuit the primary of a secondary with a soft iron core, the "unipolar" induction current in the conductor being thus detected by a second induced current. He finds that no current is induced in a conductor rotating in rigid connection with a magnet, and hence that no electrostatic charge is produced on such a conductor. It follows that the rotation of the earth regarded as a magnet can produce no electric charge on the earth's surface. W. S.

2240. *Condensers.* **A. Garbasso.** (Elettricista, Rome, 11. pp. 143–146, June, 1902. Phys. Zeitschr. 3. pp. 384–385, June 1, 1902.)—A condenser of capacity C, outer plate to earth, is charged with quantity q; the charged plate is put to earth through two wires R_1L_1 and R_2L_2, and the currents are i_1 and i_2. Mathematical treatment of the fundamental equations shows that the charge in the condenser and the currents in the wires present an oscillating and a continuous term. Under certain conditions, when one of the wires is much more resistent than the other, the continuous current passes in it by preference. When $R_1/L_1 = R_2/L_2$, the discharge takes place as if through a single wire in which $R = R_1R_2/\overline{R_1 + R_2}$ and $L = L_1L_2/\overline{L_1 + L_2}$.

A. D.

DISCHARGE AND OSCILLATIONS.

2241. *Dispersion of Electricity in the Air.* **W. W. Schipitschinsky.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 3b. pp. 47–49, 1902.)—The author points out the necessity of taking due account of the differences of apparatus, when comparing the results obtained by W. Loevy on the dispersion of electricity in the air [see Abstract No. 702 (1902)], with the outcome of Elster and Geitel's work in the same line. Many seeming divergences may thus be interpreted. A. G.

2242. *Velocity of Ions from Hot Platinum Wires.* **C. D. Child.** (Phys. Rev. 14. pp. 221–246, April, and pp. 265–279, May-June, 1902.)—This paper deals principally with the discharge from a hot platinum wire in other gases than air, and in a vacuum. There are present about the wire, particles which diminish the velocity of the ions, and these particles come from the hot platinum, not from the copper connections. They have a greater retarding action on the negative ions drawn from a flame than on the positive. In hydrogen the rate of discharge is much larger than in air. The positive discharge begins at lower temperatures than the negative, but is soon surpassed by the negative, which passes through a maximum and rapidly decreases, coming to have nearly the same value as the positive when very near the melting-point. The behaviour of the wire in oxygen, CO_2 and CO is practically the same as in air. The experiments seem to show that the particles are driven off as platinum, not as some oxide of platinum. When a platinum wire is first heated in a vacuum, the rate of discharge is much greater than at any time afterwards. Heating the wire in hydrogen, to some extent restores to it the power of producing a large discharge, but no effect was thus produced on the negative discharge. The rate of discharge in a vacuum is much greater than in air at atmospheric pressures. The amount of both positive and negative discharges continually increases as the temperature of the wire is increased. The potential difference between the wire and cylinder about it has little effect on the amount of discharge in a vacuum, and in this respect it behaves differently from the wire in air at atmospheric pressures. No method was found by which the velocity of the ions in a vacuum could be determined. The phenomena observed indicate that the ionisation first occurs within the wire, and there are reasons for thinking that this part of the ionisation is produced from occluded hydrogen. W. C. H.

2243. *Electric Conductivity of Air.* **A. Pochettino** and **A. Sella.** (Accad. Lincei, Atti, 11. pp. 527–531, June 15, 1902.)—Air churned up with water (not simply bubbled through) acted in discharging a conductor as if it had picked up some radio-active substance from the water (Marcia, Rome water-supply). A. D.

2244. *Conductivity in Gases under Ultra-Violet Light.* **J. S. Townsend.** (Phil. Mag. 3. pp. 557–576, June, 1902.)—The author has repeated, with various modifications, the experiments of Stoletow, on the currents produced in gases by ultra-violet light falling on a metallic surface in the gas. The ratio of the conductivities of the gas between two plates, on one of which the light falls, can be calculated according to the author's theory [see Abstracts Nos. 1347 and 1351 (1902)], and this is compared with the value found experimentally. The results confirm the author's theory, and they also show that the increase in current observed when the plates are further separated may be explained in the same manner. R. S. W.

2245. *Sparking Potential.* **E. Warburg.** (International Physical Congress at Paris, Report, 4. pp. 117–118, 1900–1901.)—When the difference of potential between the electrodes is slowly raised there is, in ordinary air, a retardation of the discharge, which makes the measurement of the corresponding potential very difficult; but if the electrodes be exposed to ultra-violet, to Röntgen or to Becquerel rays, the appearance of the discharge occurs at a very precisely measurable potential, which is not always less with than it is without such rays. The author considers the value obtained under the influence of these rays to be the true value of the required potential-difference. When the difference of potential is suddenly raised the phenomenon becomes more complicated. [See also Abstract No. 382 (1901).] A. D.

2246. *Chemical Change and Electrical Conduction in Gases; Luminosity.* **H. E. Armstrong.** (Roy. Soc., Proc. 70. pp. 99–109, May 31, 1902.)—The author regards the recent work of Brereton Baker—who has shown that even the most vigorous chemical reactions do not take place in absence of all traces of moisture—as confirming his own view that the presence of an electrolyte is a necessary condition for chemical action to take place, and that pure gases should be perfect dielectrics. The question of electrical discharge in gases has not, as yet, been subjected to the same accurate methods as have been employed by Dixon, Baker, and Shenstone in their investigations of chemical change, but the author brings forward evidence in favour of the view that the discharge in a vacuum tube is occasioned by the presence of minute quantities of impurities derived from the soft glass from which the tubes are constructed and from the sulphuric acid and commercial phosphorus pentoxide employed in drying the gases. The luminosity of the rare earths, the incandescence of oxides generally, and the phosphorescent phenomena produced by the action of the electric discharge may all be processes of oscillatory or recurrent oxidation or polymerisation. The author holds similar views with regard to the emanations from radio-active materials and to the ionisation of air. T. H. P.

2247. *Effect of Self-Induction of a Coil in the Ultra-violet Part of the Spark Spectrum.* **E. Néculcéa.** (Comptes Rendus, 134. pp. 1494–1496, June 23, and pp. 1572–1575, June 30, 1902.)—The self-induction of the coil used ranged from 0·000602 to 0·04191 henrys, according to the number of layers used; and the spectra of the following metals were investigated: Cadmium, zinc, lead, bismuth, antimony, iron, nickel, cobalt, &c. Taking lead as an example, the authors examine the region λ = 2700 to λ = 2000, and find for twenty-two different wave-lengths the effect of the variation of self-induction. Of these only nine remain in the extreme ultra-violet, when the self-induction rises to 0·0491. A description of the optical system for obtaining the spectrograph is given. J. W. P.

2248. *Effect of Moisture upon Discharge between the Knobs of a Ruhmkorff Coil.* **H. Bordier.** (Comptes Rendus, 134. pp. 1493–1494, June 23, 1902.)—The effect of a deposit of moisture upon the knobs is to increase the ease of the spark discharge. An apparatus is described by which the knob connected to the kathode may have moisture produced on it at will, and the temperature of this may be measured. After separating the knobs so that the sparks cease to pass, the temperature of the kathode is gradually lowered, and is read at the moment of starting of the sparks and at the moment of appearance of the moisture. The phenomenon might be used for determining the saturation temperature. J. W. P.

2249. *Influence of Röntgen Rays on very small Sparks.* **R. Blondlot.** (Comptes Rendus, 134. pp. 1559–1560, June 30, 1902.)—A small spark is caused to play between the pointed ends of a copper wire in such conditions that the voltage used is just sufficient to maintain the discharge. When Röntgen rays are allowed to fall on the gap the spark becomes whiter and much more intense. This is because the rays increase the gas conductivity, and so more current passes. A large spark-gap does not show this effect because the heating and ionising power of the spark itself is so much greater as to make it unnoticeable. R. S. W.

2250. *Velocity of Ions in Flames containing Salts.* **G. Moreau.** (Comptes Rendus, 134. pp. 1575–1577, June 30, 1902.)—Two exactly similar flames come in contact with each other at about half their height. One contains vapours of the salt under experiment. A platinum electrode is placed in each flame, and the current passing from one to the other is measured for known potential differences. From these observations and a measurement of the velocity of the gas in the flame the velocity of the ions is calculated. The results are given for negative ions only, for various salts of potassium and sodium. They show that the velocity for a given concentration is independent of the anion, that it diminishes rapidly as the concentration increases, and for small concentrations tends to the same limiting value for the salts of potassium and sodium. R. S. W.

2251. *The Electric Discharge in Rarefied Gases.* **W. Wien.** (Ann. d. Physik, 8. 2. pp. 244–266, May, 1902. Also Electrician, July 18 and 25, 1902.)—The author begins by explaining the precautions necessary to obtain magnetic and electrostatic deflection of the canal rays, and goes on to describe experimental results. In the highest vacua obtainable there are no canal rays, but kathode rays can be detected, due, not to a gaseous residue, but to the metals of the electrodes. At the highest vacua the passage of the current is altered quantitatively but not qualitatively by using incandescent electrodes such as platinum or carbon filament. The author next describes the fluorescence produced by the canal rays when the tubes contain different gases. He then discusses the electrostatic deviation of the canal rays, and describes the changes in the fluorescence when they are accelerated by electrostatic force. Finally he gives his results for change of fluorescence, and for deviation under the combined influence of magnetic and electrostatic force, giving the value of the ratio e/m for the most deviable rays in various gases. He concludes with certainty that the small deviation of a part of the canal rays is due to alteration of the ratio of charge to mass along the path of such rays, and that some, if not all, of the canal-ray group are due to the gaseous contents of the tube. The canal rays are being continually reconverted into neutral gas, a cyclic process thus going on during the discharge. W. S.

2252. *The Canal-Ray Group.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 4. 10. pp. 228–244, May 30, 1902.)—One may speak of a canal-ray group, inasmuch as several kinds of ray exist which have some properties in common with the canal rays proper, though at the same time they differ in other respects. The author considers that hitherto insufficient attention has been paid to the part played by the apertures used in the kathode, and describes phenomena observed with various forms of opening. He concludes from his experiments that at least five different members of the canal-ray group can be distinguished, which are as follows: I. The first layer of the kathode light. It has been supposed that the canal rays are identical with those, being merely rays of the first layer which have passed unchanged through the openings in the kathode. This supposition has been disproved by Goldstein [see Abstract No. 1900 (1902)], who has shown that the rays of the first layer are very sensitive to influences which scarcely affect the true canal rays. II. The true canal rays, which issue in straight lines from the openings in the kathode, and from the side turned away from the anode; they cannot be sensibly deflected by small magnetic or electrostatic forces. III. Those rays which emanate from kathodes with or without openings, and proceed towards the anode from the side next it; they may be observed when the ordinary kathode rays are deflected to one side by a magnetic field, and are no more sensitive to electric and magnetic forces than are the true canal rays. IV. *Regular* cloudy rays which envelop the true canal rays. V. *Diffuse* cloudy rays which seem to bear to the regular cloudy rays and the true canal rays the same relation which the light of the third kathode layer bears to the ordinary regular kathode rays; that is, they seem to be produced by the true canal rays striking the gaseous particles. W. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2253. *Dielectrics at Low Temperatures.* **J. Curie** and **P. Compan.** (Comptes Rendus, 134. pp. 1295–1297, June 2, 1902.)—The authors have investigated the specific inductive powers of different solid dielectrics at low temperatures, the arrangement being as described by J. Curie in Ann. de Chim. et de Phys., 1889. The present paper refers only to tests upon glass. Three specimens of microscope (crown) glass were used, and were found to give analogous results; but certain differences in the same specimen are to be observed, depending upon the duration of the successive temperature conditions, the time-interval of charge, and upon whether the temperature is varied by successive increments of heating or of cooling. In the following table the specific inductive powers at different temperatures C. are set forth for different times of charge. The letter *d* placed at the side of a number indicates that the value is obtained for descending temperatures, and the letter *r* represents a cycle of rising temperatures.

Duration of Charge, in Seconds.	Temperature C.				
	+ 13°	C°	− 19°	− 75°	− 185°
10	11·25	9·47	8·44	7·09	6·49
1	9·32	8·44	7·81	7·09	6·49
0·1	8·04*d* 7·75*r*	7·75*d* 7·52*r*	7·42	7·09	6·49
0·05	7·85*d* 7·59*r*	7·50*d* 7·42*r*	7·36	7·09	6·49

So far as these tests go, they appear to indicate that at temperatures lower than − 75° C. the inductive power of glass is independent of the duration of charge between the limits 0·05 seconds and 10 seconds. For short charges the inductive power of glass varies only slightly with temperature. The inductive power of glass increases with temperature according to a law of the form $k = k_0 + \mathrm{A}\mathrm{T}$, where k_0 is a constant which should be the inductive power at absolute zero, and where T is the temperature on the absolute scale. A is a constant characteristic of the substance. For the three specimens of glass examined the values of k_0 and A were found to be as follows:—

Specimen No.	k_0	A
1	6·03	0·00524
2	6·83	0·00520
3	6·24	0·00533

Analogous results have been found for ebonite, mica, and quartz, and a similar linear law is said to hold for them. R. A.

2254. *Dielectric Constant of Glass by Electric Waves.* **J. A. Pollock** and **O. U. Vonwiller.** (Phil. Mag. 3. pp. 586–606, June, 1902.)—In this investigation electric waves were generated by the discharge of a condenser whose dielectric was at pleasure glass or air of an equivalent thickness. This thickness of air was ascertained by observations of waves induced on a short system of parallel wires with or without bridges. All the specimens of glass used were "thick polished plate glass" from Floreffe, Belgium. The dielectric constant under alternating electric forces with a frequency of twenty million per second was found to be 7·87 at 26° C., whereas that found by an absolute electrometer method for alternations of 50 per second at 25·5° C. was 7·79, or practically the same. E. H. B.

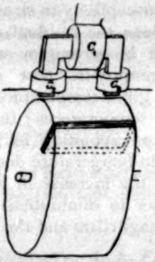
2255. *Conductors of the Second Class.* **A. Kiesewalter.** (Schweizerische Blätter für Elektrotechnik, 7. pp. 49–51, April 8, 1902.)—The development of the Nernst lamp and the employment of so-called conductors of the second class, have led the author to investigate the latter. Two classes of these conductors are important. Class 1. Earths and earthy metals combined with fixed acids, such as, for instance, alumina, generally in combination with SiO_2. Class 2 Alkaline earths combined with volatile acids, such as lime, magnesia, baryta combined with CO_2, and HF. The infusibility of alumina combined with alumina silicates, decreases with the increase of SiO_2, and also Fe, alkalis, Ca and Mg, until it will not stand more than 800° C. without melting, whereas a true mono-silicate is not affected up to 1,840°, and even more. The two methods employed by Bishop and Segner for gauging the melting-point of such bodies are compared, preference being given to the latter, as it entails the employment of fusible cones (590° C. to 1,840° C.). The following results were obtained : Clay (alumina with 30 per cent. silica) was melted at a temperature of a No. 30 cone, using rods of 6 mm. diameter and 25 mm. long, the operation being carried out in a Deville furnace. A similar rod, after heating in a Bunsen flame, readily melted at an e.m.f. of 120 volts. By using 25 volts only, the rod could be made to grow luminous. After cooling, the rod was found to be in a spongy condition. According to the author, this is due to the presence of 1½ per cent. of soda. Classes 1 and 2 gave similar results. The more refractory the substance the less time was required to render the substance conductive by means of the Bunsen flame. Further experiment proved that the presence of alkalis had a detrimental effect upon the conductivity, and they must therefore be avoided. Materials heated in a magnesia crucible to about 2,000° C. in a Deville furnace became luminous on passing a current of 50 to 80 volts, the luminosity being controlled at will by altering the e.m.f. The author states that the emission of light is the result of waves produced by the current, and not by the effect of heat only, as a No. 36 Segner cone heated to 1,840° C. did not give off any considerable quantity of light. For the purpose of producing electric light by conductors of the second class, only such alkaline earths are of use, the melting of which is beyond the temperature produced by an e.m.f. customary for the purpose of electric lighting. The following oxides are suitable for this purpose : Chemically pure oxides of silicon, magnesium, barium, calcium, aluminium, and Zirconium. The melting-points of these bodies lie between 2,000° and 2,500° C. They should be used by themselves and not mixed together, as this causes a considerable drop in their melting-points. Finally, the author draws attention to the fact that these bodies volatilise, and in some cases sinter together, and thereby occasionally crack. He again draws attention to the fact that the more refractory the bodies the less time is required to render them conductive. A third group of bodies which the author is experimenting with, and which will form the subject of a future communication, do not require preliminary heating, at the same time being sufficiently refractory.
O. J. S.

2256. *Simple Radio-conductors.* **F. Piola.** (Elettricista, Rome, 11. pp. 137–141, June, 1902.)—The resistance assumed by a radio-conductor (two steel bicycle balls in petroleum) originally not conducting, is approximately inversely proportional to the quantity of electricity which is discharged on to them when such discharge is produced by condensers of sufficiently small capacity. A. D.

2257. *Mercury Current-Interrupter.* **W. A. Del Mar.** (Amer. Electn. 14. pp. 295–297, June, 1902.)—One end of the iron core of the induction coil is filed away at a slant of 45° with the horizon. The moving armature is a small portion of a cylinder of iron co-axial with the core and filed to a corresponding slant; it is supported by a horizontal straight spring, fixed so that the two slant faces are brought near to one another. The armature is thus able to move up and down with respect to the core. A vertical iron rod attached to the armature dips into a mercury cup, and contact is made and broken in the usual way. It is claimed that this arrangement enables adjustments to be easily made. R. A.

ALTERNATING CURRENTS AND MAGNETISM.

2258. *New Wave-Form Apparatus.* **R. Goldschmidt.** (Elektrotechn. Zeitschr. 23. pp. 496–497, June 5, 1902.)—The construction of the apparatus will be understood from the accompanying diagram, in which C_1 is the primary, and C_2 the secondary coil of a small transformer having a ⊓-shaped core. The primary coil is connected to the source of alternating e.m.f., or is introduced into the circuit in which the current-wave is to be determined. The secondary coil is joined in series with a suitable alternate-current voltmeter and the secondary coil of another small "compensating" transformer (closed magnetic circuit), the e.m.f.'s in the secondaries opposing each other so that the changes of induction due to the p.d. or current-wave in C_1 are without effect on the voltmeter. Close to the projecting ends of the ⊓-shaped core is rotated (synchronously) a drum, into which are let a few thin strips of soft sheet-iron; these form the movable yoke of the core, and it is evident that every time this yoke passes the core a very sudden increase and decrease in the magnetic flux will take place, and the voltmeter will give a reading proportional to the instantaneous value of the current in C_1. The small transformer is mounted on an arm capable of rotation about the axis of the drum, and may be clamped in various positions, corresponding to different values of the instantaneous p.d. or current. The method of using the appa-



ratus is precisely similar to that employed with a Joubert contact-disc, but it possesses the great advantage of doing away with the difficulty due to uncertainty of contact. Samples of curves obtained with this form of apparatus are given by the author. A. H.

2259. *Heating of Non-Magnetic Rods by Foucault Currents.* **W. Ignatowsky.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 3b. pp. 49–61, 190?.)—The author gives the mathematical theory of the following laboratory experiment: An alternate current being made to traverse an induction coil containing a copper rod, the quantity $W = CE \cos\phi$ is found by means of a wattmeter. C and E are subsequently derived from the readings of a voltmeter and an ammeter, $\cos\phi = W/CE$ being thus determined. Now $W = C^2R + W_1$, where C^2R is the energy corresponding to the Joule heat evolved in the circuit, and W_1 the energy lost by the Foucault currents in the rod. Taking out the rod, the wattmeter will give $W_0 = C^2R$, and therefore $W_1 = W - W_0$. The theoretical deductions given in this paper fully warrant this method of measuring W_1. A. G.

2260. *Magnetic Constants of Iron.* **D. Mazzotto.** (N. Cimento, 3. pp. 417–442, June, 1902. Bologna Congress of the Soc. Ital. di Fisica, Sept. 27, 1901.)—If iron be heated to a red heat and then exposed for a long time to a uniform temperature far below a red heat, its magnetic constants vary slowly towards a stable limiting value which depends upon that temperature; the susceptivity and permeability diminish, while the residual magnetism, the coercitive force, and the field of maximum susceptivity increase; and these changes are more marked but slower in manifesting themselves the lower the temperature (down to 100°) at which the iron is maintained. The difference between red-hot iron and long-tempered iron in respect of the susceptivity in equal fields, which is most marked in feeble fields, diminishes as we pass from the field of maximum susceptivity to stronger fields, and in strong fields it vanishes. The ratio between the residual magnetism in the two cases is the same whether the field be strong or weak. The changes are most marked and appear most promptly in "best" iron, next in Swedish, least so in steel. Long exposure to a given temperature does not render iron immune from other changes at other temperatures; the magnetic constants tend to reach the limiting values corresponding to the new temperatures. Since protracted exposure to a given temperature does not alter the susceptivity in strong fields, it appears that the increase in hysteresis losses in alternating current machines is due, not to diminutions in the permeability, but to increases in the permanent magnetism and the coercitive force of the cores. A. D.

2261. *Magnetism of Compounds of Iron and Silicon.* **A. Jouve.** (Comptes Rendus, 134. pp. 1577–1579, June 30, 1902.)—The attractive power of an electromagnet on a constant mass of the material is measured for different percentages of silicon. To do this the alloy is powdered and put in a small box. Brusque changes are noticed when the silicon is 20 per cent. and 33 per cent. of the mixture. Definite compounds of iron and silicon, Fe_2Si and FeSi, are hence inferred. R. S. W.

2262. *Magnetic Properties of Alloys of Nickel.* **B. Hill.** (Deutsch. Phys. Gesell., Verh. 4. 9. pp. 194–203, May 9, 1902.)—Following his research on other alloys, the author investigates the effect of increasing the amount of alloying metal, copper or zinc, on the properties of nickel. In the case of the copper alloys he takes 4, 8, 20, and 40 per cent. of copper; placing one rod of the alloy at a time wound with (1) primary coil, (2) secondary coil, and (3) heating coil, he finds the change in magnetic intensity as temperature changes. He takes van't Hoff's formula, $\Delta t = 0{\cdot}02mT^2/ML$, which applies to the lowering in freezing-point (Δt) as m grams of salt are dissolved in 100 of solvent, M being the molecular weight of the salt, T absolute temperature, and L the latent heat of the change of state. Apply this to the change in the transformation temperature of the alloys. According as more or less (m) alloy is introduced he finds the expression holds good with considerable accuracy. In the case of the tin alloys the percentages of tin are 5, 10, 15. Here again the formula applies well. Thus the ratio $\Delta t/m$ gives values 7·4, 7·2, 7·3 for the three alloys. P. E. S.

2263. *Magnetic Disturbances during the Mont Pelée Eruption.* **L. A. Bauer.** (Terrestrial Magnetism, 7. pp. 57–58, June, 1902.)—Magnetic disturbances occurred at the observatories of Cheltenham, Maryland, and Baldwin, Kansas, simultaneously with the eruption of Mount Pelée on May 8, and the reports from Toronto, Honolulu, Stonyhurst, Val Joyeux, Potsdam, and Pola, show that the disturbance was general. Strikingly similar records were obtained in the preceding weeks, and again on May 20; the Guatemala earthquake of May 18 also seems to have given rise to magnetic disturbances. The magnetograms of May 7–8, obtained at Cheltenham with the Adie magnetograph, are reproduced. H. B.

2264. *Magnetic Survey of Central Madagascar.* **Colin.** (Comptes Rendus, 134. pp. 1274–1278, June 2; and pp. 1339–1341, June 9, 1902.)—The Ankaratra Plateau of Central Madagascar is distinctly of volcanic origin though active volcanoes are unknown. The author has determined the magnetic elements at thirty-five stations, and observed many remarkable anomalies; the direct influence of the volcanic zones appears, however, to be local. The first paper tabulates the observations, the second paper contains comments. H. B.

REFERENCES.

2265. *Decimal Unit of Time.* **J. de Rey-Pailhade.** (International Physical Congress at Paris, Report, 4. pp. 65–68, 1900–1901.) [See Abstract No. 724 (1902).] A. D.

2266. *The Electronic Theory of Electricity.* **J. A. Fleming.** (Popular Science, Monthly, 61. No. 1, pp. 5–24, 1902.)—The paper contains a general sketch of the history and present position of the theory. G. W. DE T.

2267. *Reflexion of Kathode Rays.* **H. Starke.** (Deutsch. Phys. Gesell., Verh. 4. 9. pp. 212–224, May 9, 1902.)—The paper criticises the results obtained by Austin and Starke on the reflexion of kathode rays. Further examination, according to the author, only serves to confirm the results he and Austin obtained. [See Abstract No. 2077 (1902).] R. S. W.

2268. *Reflexion of Kathode Rays.* **J. Stark.** (Phys. Zeitschr. 3. pp. 368–373, May 15, 1902.)—A paper in support of the author's theory as opposed to the results of Austin and Starke. [See preceding Abstract.] R. S. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2269. *Weight and Chemical Transformation.* **Rayleigh.** (Nature, 66. pp. 58-59, May 15, 1902.)—The author refers to the inference drawn by Heydweiller [see Abstract No. 1760 (1901)] from some of his experiments, that certain chemical transformations are attended by minute changes of weight. He then argues from thermodynamical considerations that such changes in weight are inadmissible, except on the hypothesis that hitherto unsuspected thermal effects accompany a rising or falling against or with gravity. G. W. DE T.

2270. *Polymorphism and Chemical Isomerism.* **G. Bruni.** (Accad. Lincei, Atti, 11. pp. 386-389, May 4, 1902.)—This is a continuation of the author's essays on the properties of mixtures of isomeric bodies [see Abstracts Nos. 485 and 1402 (1899) and 539 (1900)], dealing in this case chiefly with the points of congelation. He agrees with Wegscheider (Wiener Monats. f. Chem. cxxii. 917, 1901) as to the propriety and convenience of a distinction between polymorphs and isomers, and points out that "of two polymorphous bodies, one only has a stable fusion-point; the point of fusion of the other corresponds to a state of unstable equilibrium which the smallest trace of the first modification can cause to disappear. On the other hand, two isomeric bodies have each a stable fusion-point in the sense of the theory of phases." S. R.

2271. *Atomic Weight of Calcium, II.* **F. W. Hinrichsen.** (Zeitschr. Phys. Chem. 40. pp. 746-749, May 20, 1902.)—By heating pure native calcite the author had obtained the number 40·142 ($O=16$) [see Abstract No. 731 (1902)]. He has repeated his determinations on a very pure calcite from the Crimea, in which the traces of impurities were carefully determined and allowed for. The heating was effected in an electric oven at 1,200-1,400°, and gave the values 40·139 and 40·136. S. R.

2272. *Classification of the Elements.* **H. E. Armstrong.** (Roy. Soc., Proc. 70. pp. 86-94, May 31, 1902.)—This is an arrangement in sixteen columns, taking the "elementary difference" as about a single unit; so that the elements are entered under whole numbers, neglecting the exact atomic weights; the first horizontal period comes to an end with oxygen. Several new groupings result similarly to the familiar ones of the iron and platinum metals. Tellurium is placed before iodine, with an atomic weight of 124. S. R.

2273. *Suggested Modifications of the Sign of Equality for Use in Chemical Notation.* **H. Marshall.** (Roy. Soc. Edinburgh, Proc. 24. pp. 85-87, May, 1902.)—The sign with opposite arrows now employed for reversible equations is the same as that often used in organic chemistry to indicate that each of the two substances concerned may serve as starting-point for the preparation of the other. The author suggests a pair of singly barbed arrows as a better means of representing reversible reactions, and advocates the adoption of such a sign for all complete chemical questions. For irreversible actions the sign would be $\substack{\rightharpoonup \\ \rightharpoondown}$, for reversible actions $\rightleftharpoons$, while for reversible actions associated with a definite transition temperature he suggests $\rightleftarrows$ with a figure above giving the temperature involved. When the action under ordinary conditions goes almost wholly in one direction, or there is doubt as to its reversibility, the sign $\overset{\longrightarrow}{\relbar\relbar}$ is proposed. S. R.

2274. *Molecular Complexity of Acetic Acid in Chloroform Solution.* **H. M. Dawson.** (Chem. Soc., Journ. 81. and 82. pp. 521–524, May, 1902.)—From previous experiments [see Abstract No. 2294 (1902)] it had been found that the distribution-ratio of acetic acid between water and chloroform varies very considerably with the concentration. On the assumption that this is due to the existence of dissociating double acetic acid molecules in the chloroform, the dissociation-isotherm in the chloroform solution can be readily written down. This equation involves two unknowns, r the distribution ratio of the simple molecules and K the dissociation-constant. Two experiments serve to determine r by elimination of K, and from this value of r values of K can then be calculated from the data of the remaining experiments. The values of K so obtained remain practically constant while the concentration of the acetic acid in the chloroform undergoes a change in the ratio of 1 to 40.

F. G. D.

2275. *Double-Salts of Magnesium and Zinc Sulphates.* **R. Hollmann.** (Zeitschr. Phys. Chem. 40. pp. 577–580, May 13, 1902.)—It has already been shown [see Abstract No. 1737 (1901)] from the vapour-tension curve of mixed crystals of $ZnSO_4 . 7H_2O$ and $MgSO_4 . 7H_2O$ that these two salts form double salts $MgZn(SO_4)_2 . 14H_2O$ and $Mg_2Zn(SO_4)_3 . 21H_2O$ which are isomorphous with each other and with their constituents. Similar results have now been obtained by studying the temperature at which the crystals decompose into the hexahydrated form. This temperature, which is at 48·5° in the case of pure $ZnSO_4 . 7H_2O$, falls to a minimum at 44·4° when the crystals have the composition $ZnMg_2(SO_4)_3 . 21H_2O$, rises to a maximum at 44·9° and falls to a second minimum at 43·1°, when the crystals have the composition $ZnMg (SO_4)_2 . 14H_2O$, and after rising to a second maximum falls to 38·7° in the case of pure $MgSO_4 . 7H_2O$. T. M. L.

2276. *Calculation of Solubilities and Equilibrium Constants. Formula for Latent Heats of Vaporisation.* **A. Findlay.** (Roy. Soc., Proc. 69. pp. 471–478, April 4, 1902.)—The theory of corresponding states, which was used by Ramsay and Young to calculate the vapour pressure of one liquid from that of another by determining the ratio at two temperatures only, is now applied to the calculation of solubilities. In the equation $R = R' + c(t' - t)$, c is a constant, and R R′ are the ratios of the absolute temperatures at which the two substances have equal solubilities, and t' and t are the actual temperatures for one of the substances. Thus $ZnBr_2$ and $ZnCl_2, H_2O$ have equal solubilities at 313·0° and 283·9° (abs.) and again at 338·0° and 286·2° (abs.); from these values c is calculated to be 0·00316. The temperature at which zinc chloride has a given solubility can then be calculated if the corresponding temperature for zinc bromide be known. The maximum error in seven observations was 0·7° C. Tables are also given for KBr, and KCl, KNO_3 and $CdBr_2, 4H_2O$, and *m* and *p* hydroxybenzoic acids. A similar method is applied to the equilibrium constants of the equations $2HI \rightleftharpoons H_2 + I_2$ and $2CH_3 . CO . CH_3 \rightleftharpoons CH_3 . CO . CH_2 . C(CH_3)_2 . OH$. For calculating the latent heat of vaporisation the formula $L_1 = L_2 T_2^x$ is given, where L_1 is the latent heat of a standard substance at temperature T_1, T_2 is the temperature at which the second substance has the same vapour pressure as the standard at temperature T_1, x is a constant, and L_2 is the required latent heat of the second substance at temperature T_2.

T. M. L.

2277. *Solutions of Gases in Liquids.* **J. A. Wanklyn.** (Phil. Mag. 3. pp. 346–348, March, and pp. 498–500, May, 1902).—Carbon dioxide is capable of being absorbed by water without any shaking, the absorption being at the rate of about 0·375 c.c. per hour for each sq. cm. of surface. If, however, carbon dioxide be placed over its saturated solution, and strong potash is carefully placed below the aqueous layer, the volume of gas remains constant during 48 hours, but vanishes in a few minutes when the contents of the tube are shaken. This result serves to show that the rate of diffusion of carbon dioxide in aqueous solution is exceedingly slow. The author considers that the experiment establishes the fact that the single molecules of CO_2 are attached to many molecules of H_2O, forming large compound molecules. The absorption of CO_2 by pure water, which proceeds much more rapidly, may be accounted for by the density of the CO_2 solution, which is greater than that of water and would tend to set up convection currents. Similar experiments were made with ammonia, the column of gas (38·2 c.c.) being separated from a column of water (5·5 c.c.) by means of a column of saturated solution (7·5 c.c.). When the experiment was set up the volume of gas was 34·8 c.c., which decreased after three hours to 23·1 c.c., after ten hours to 7·13 c.c., and disappeared instantly on slight shaking. In this case, therefore, the gas diffuses only with great slowness, and it is suggested that in the purification of water a layer of still water 4 in. thick would protect organic matter from the oxidising action of the atmosphere for more than a month.

T. M. L.

2278. *Slow Oxidation of Methane at Low Temperatures.* **W. A. Bone** and **R. V. Wheeler.** (Chem. Soc., Journ. 81. and 82. pp. 535–549, May, 1902.)—Mixtures of methane and oxygen, sealed, at atmospheric pressure, in cylindrical bulbs of boro-silicate glass with capillary ends, were maintained for several days at 300–400°, then opened under mercury, and the gas analysed. It was found that at these temperatures combination ensues with an enormously greater velocity than it does between hydrogen and oxygen. The sole products obtained were water, CO and CO_2; free H or C was not detected at any stage. Figures are given of apparatus for the preparation of the gas and manipulation of the bulbs. The experiments are being extended to other hydrocarbons.

S. R.

2279. *Diffusion of Hydrogen through Platinum.* **A. Winkelmann.** (Ann. d. Physik, 8. 2. pp. 388–404, May, 1902.)—The author describes the methods and apparatus employed in his investigations, and from the results obtained the following conclusions are drawn: (1) The diffusion of hydrogen through glowing platinum does not proceed proportionally to the pressure of the gas. (2) This diffusion is most probably accompanied by a dissociation of the hydrogen molecule, so that only the atoms, and not the molecules, of the gas pass through the platinum. Assuming that such dissociation occurs, the author applies the mass laws to the derivation of a formula for the constant of diffusion. [See also Abstract No. 2195 (1901).]

T. H. P.

2280. *Extension of the Concept of Critical Quantities.* **A. Batschinski.** (Zeitschr. Phys. Chem. 40. pp. 629–634, May 13, 1902.)—Designating substances for which the molecule of the liquid is similar to that of the saturated vapour as orthomeric, and others as allomeric, the author suggests that an orthomeric polymerised substance may be brought under the law of corresponding states by substituting, for the critical constants, determinate functions of the pressure and temperature, which he calls metacritical, and which at the critical point become identical with the critical constants. A physical interpretation might be given to these functions, if, for example, it were a realisable process to bring a substance from a given condition into the state in which there is no difference between the fluid and its vapour, without allowing any change to occur in its polymerisation ; the final temperature and pressure would be the corresponding values of the metacritical functions. A method is explained, and applied to the case of acetic acid, of determining the values of these functions when the specific volumes of an orthomeric substance in the fluid and vapour states are known for different boiling-points and different pressures, or the theory of the viscosity of liquids might be used for the same purpose. W. E. T.

2281. *Synthetic Analysis in Ternary Systems.* **A. W. Browne.** (Journ. Phys. Chem. 6. pp. 287–312, May, 1902.)—The results are given of experimental applications of the method suggested by Bancroft [see Abstract No. 1915 (1902)] for analysing the solid phase appearing in three component systems without removing it from the mother-liquor. Of the many possibilities regarding the composition of the solid phase, three cases are illustrated by the experiments, viz., where it is (1) a pure component, by the system potassium chloride, hydrochloric acid and water ; (2) a binary compound of components, by the systems (*a*) sodium sulphate, sodium chloride and water, (*b*) barium chloride, hydrochloric acid and water, (*c*) ferric chloride, hydrochloric acid and water ; (3) a binary solid solution, by the system potassium sulphate, ammonium sulphate and water. Both the direct and zero methods are employed, and the utility of the triangular diagram for assigning the limits of error is explained. The author suggests that with special precautions the method might be applied to the determination of the atomic weights of certain elements. W. E. T.

2282. *Indifferent Points.* **P. Saurel.** (Journ. Phys. Chem. 6. pp. 313–320, May, 1902.)—According to Duhem, an indifferent point is such that, at the corresponding temperature and pressure, a reversible change is possible in which the masses of the phases vary while their concentrations remain unchanged. The author has previously obtained in a general analytical form the necessary and sufficient conditions which must hold at such an indifferent point [see Abstract No. 937 (1901)]. The present paper is concerned with the same question as viewed from a geometrical point of view. The result is as follows : In order that a multivariant system of r phases may be at an indifferent point, it is necessary and sufficient that the representative point of the system and the representative points of the r phases lie in the same flat space of $r-2$ dimensions. F. G. D.

2283. *Equilibria in Systems of Three Components in which Two Liquid Phases can occur.* **P. A. Meerburg.** (Zeitschr. Phys. Chem. 40. pp. 641–688, May 20, 1902. Abstract of author's dissertation, "Influence of a Third Substance on the Equilibrium in the System Triethylamine–Water," Leyden, 1900.)—In this paper, which is a continuation of Schreinemaker's work, three component systems are studied in which two of the components taken alone exhibit a so-called lower critical mixing temperature, *i.e.*, these two components are such that they form at lower temperatures a homogeneous liquid phase which at higher temperatures breaks up into two liquid phases. The systems studied contain triethylamine and water in every case, as these are the two components exhibiting the above phenomenon. The third component chosen is either ethyl alcohol, diethyl ether or phenol. For details of the work, which is a phase-law study of the various equilibria, reference must be made to the original. F. G. D.

2284. *Velocity of Combination of Heterocyclic Compounds with Bromhydrine.* **N. Menschutkin.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 4a. pp. 411–422, 1902.)—The author shows that in all cases tested, with open as well as with closed chains, the influence of a lateral chain upon the velocity of reaction is manifested in the same sense, viz., as a delay. This uniformity obviously suggests the hypothesis that one and the same cause may produce this effect. This cause cannot be the structure of the chain, as the effect of introducing a given lateral chain is identical, though this structure be most different. The possibility of the existence of a so-called sterical hindrance is therefore discussed, and though on this hypothesis most of the phenomena may be explained, chemical factors are likely to play a not unimportant part as well. A. G.

2285. *Velocity of Formation of Simple Ethers.* **M. Rosenfeld-Freiberg.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 4a. pp. 422–431, 1902.)—The author investigates the velocity of formation of simple ethers from the reaction of sulpho-benzolic ethers upon alcohols, it being shown that the constant velocity will undergo very regular variations, analogous to and in the same sense as those exhibited by physical properties, such as melting-points and specific weights, according to the nature of the sulpho-benzolic ether as well as the alcohol reacting, those constants decreasing from the methylic ether to the iso-amylic ether on the one hand, and from the methylic alcohol down to the octylic alcohol on the other, the latter confirming Zagrebin's views. In addition, great differences are found to exist between the constants corresponding to different modes of formation of one and the same mixed simple ether. A. G.

2286. *Micro-constituents of Steel.* **J. E. Stead.** (Engineering, 73. pp. 645–646, May 16, 1902.)—The original observation of Sorby, that properly hardened 0·9 per cent. carbon tool-steels, though they may be minutely crystalline are practically structureless, is correct. Roberts-Austen states that it requires a magnification of 1,000 diameters to exhibit the crystalline structure, and this is confirmed by the photographs of Osmond. The author has measured the sides of one of the crystalline triangles and finds it to be 0·0001 in., whilst many appear to be much smaller. After six hours' heating at 800° C. and quenching from 700° C., the crystals were thirty times larger. When small bars of steel are heated at one end to 800° or 900° C. for several hours the sections exhibit the effects of gradually changing temperatures, and the transition-point, &c., is very clearly shown. If the carbon is low (0·1 per cent.) and the original structure coarse, the point Ac_3 is also revealed, for at this point the coarse ferrite structure becomes broken up.

Between 620° and 670° segregation of the cementite and ferrite which compose the pearlite eutectic occurs, and a maximum of softness is obtained by annealing within these limits. T. M. L.

2287. *Alloys of Cadmium with Barium and with Calcium.* **H. Gautier.** (Comptes Rendus, 134. pp. 1054–1056, May 5, 1902.)—The author gives an account of the preparation of alloys of cadmium with calcium and barium, by the method already used by him for the corresponding strontium compound (C.R. 133, p. 1005). Cadmium and sodium are heated in a closed crucible for about two hours at a red heat, with the iodide of the alkaline earth metal; the alloy is thus obtained as a button containing about 16 per cent. to 18 per cent. of calcium or barium. The proportion of earth metal may be increased by distilling the alloy in vacuo; the calcium under similar conditions appears to be less volatile than strontium or barium, so that its alloys may be obtained with a percentage of 55 of calcium. The Ca-Cd and the Ba-Cd alloys are more brittle and less susceptible of potash than the Sr-Cd alloys. As described by the author in detail, the cadmium alloys of the earth metals behave quite similarly, to different chemical reagents. D. H. J.

2288. *Dissociation of Radio-active and other Elements.* **G. Martin.** (Chem. News, 85. pp. 205–206, May 2, 1902.)—The dissociation of the terrestrial elements at solar and stellar temperatures is represented by dissociation of the radio-active elements at ordinary terrestrial temperatures. There is a tendency to such dissociation among other elements, and is the greater the higher the temperature, and the greater the atomic weight within any Mendelejeff periodic group. At ordinary temperatures ferric chloride is the most stable form; at high temperatures ferrous chloride; the iron atom has shed one of its three electrons. Even at ordinary temperatures zinc sheds electrons, which can affect a photographic plate (Russell). Gases when heated to incandescence shed free electrons and become conductors of electricity; carbon increases greatly in conductivity at high temperatures; hot metals act like radio-active bodies in charging and discharging electroscopes. Probably atoms may break up into positively charged particles (deviable), negatively charged particles (deviable), and inactive particles composed of the unelectrified matter which composes the bulk of the atom. A. D.

2289. *Decomposition of Hydrated Mixed Crystals.* **R. Hollmann.** (Zeitschr. Phys. Chem. 40. pp. 561–576, May 13, 1902. Paper read before the 11. Kongress Russischer Naturforscher und Ärzte in St. Petersburg, Jan. 5, 1902.)—The transition-temperature of hydrated mixed crystals when in contact with the solution varies with the composition of the mixture. Three chief cases are possible in which (1) the transition-temperature of the mixed crystals lies between those of the components; (2) the decomposition curve shows a maximum, or (3) a minimum; these are again subdivided. If crystals of two degrees of hydration can separate from a solution together the mixed crystals of the higher hydrate are richer than those of the lower hydrate in the component which tends to raise the transition-temperature. As an example of the first case the behaviour of the sulphates of manganese and zinc is quoted, the transition-temperature rising continuously from 10° ($MnSO_4.7H_2O$) to 40° ($ZnSO_4.7H_2O$). The sulphates of manganese and copper afford an example of a maximum in the curve. Retgers has shown that at about 10° a heptahydrate can exist in mixed crystals with 4·92–37·8 mols. per cent. of $CuSO_4$, whilst Stortenbeker working at 18° found these limits narrowed to 16–23·5 per cent. Cu, and "in summer weather" above 21° only the pentahydrate was formed; the maximum temperature at which a heptahydrate can exist is therefore at about 20° in crystals containing about 20 mols. per cent. $CuSO_4$. [See also Abstract No. 1143 (1902).] T. M. L.

2290. *Conductivity of Electrolytes with Univalent Ions in Aqueous Solution.* **F. Kohlrausch** and **H. v. Steinwehr.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 26. pp. 581–587, May 29, 1902.)—Very accurate measurements of the conductivity of salts containing the ions K, Na, Li, Cl, NO_3, IO_3, have already been made [see Abstracts Nos. 250 (1900), and 913 (1901)]; similar measurements have now been made in the case of the salts CsCl, TlCl, KI, KBr, KCNS, KF, NaF, TlF, $TlNO_3$, $AgNO_3$ and $KClO_3$. The solutions examined varied in strength from normal to N/10000, and the values of the equivalent conductivity Λ_∞ at infinite dilution were deduced by means of the formula $\Lambda_\infty - \Lambda/\Lambda^p = C.m^{\frac{1}{3}}$ from the values observed in the very dilute solutions. From the values of Λ_∞ now deduced the ionic mobilities of the ions Cs, Ag, Tl, I, Br, CNS, F and ClO, can be accurately determined.

The following table gives the accurate values now adopted for the mobilities of the univalent ions:—

Li	Na	K	Rb	Cs	NH_4	Tl	Ag	F	Cl	Br	I	CNS	NO_3	ClO_3	IO_3
33·44	43·55	64·67	67·6	68·2	64·4	66·00	54·02	46·64	65·44	67·63	66·40	56·63	61·78	55·03	33·87

whilst less accurately determined values are BrO_3 46·2, ClO_4 64·7, IO_4 47·7, MnO_4 53·4, and for the radicles of the fatty acids—

CHO_2	$C_2H_3O_2$	$C_3H_5O_2$	$C_4H_7O_2$	$C_5H_9O_2$	$C_6H_{11}O_2$
46·7	35·0	31·0	27·6	25·7	24·3

In the case of thallium fluoride values of the equivalent conductivity were obtained which in the case of solutions more dilute than N/500 were greater than the sum of the ionic mobilities. This is probably due to hydrolytic dissociation of the salt giving rise to thallium hydroxide and hydrogen fluoride. T. M. L.

2291. *Temperature Variations of Specific Molecular Conductivity and of Fluidity of Sodium Chloride Solutions.* **T. R. Lyle** and **R. Hosking.** (Phil. Mag. 3. pp. 487–498, May, 1902.)—Determinations were made between 0° and 100° of the density, fluidity, and conductivity of sodium chloride solutions, the three instruments being contained in one bath, and measurements made every 10° C. The values obtained were corrected for the change of concentration due to expansion, and smoothed values of the density, fluidity, and conductivity are given for each 10° from 0° to 100° (also for 15° and 18°) for concentrations 0·1, 0·2, 0·5, 1·0, 2·0, and 4·0 normal, and also by extrapolation for solutions of infinite dilution ($n = 0·0$). The curves showing the influence of temperature on conductivity would indicate that for solutions of the strengths experimented with, both properties would tend to a zero value at $-35·5°$ C. [See Abstract No. 524 (1902).] But the curves representing the two properties are by no means identical, the fluidity in all cases increasing much more rapidly than the conductivity as the temperature rises. The ratio conductivity/fluidity has a temperature coefficient which is of the same order of magnitude for all concentrations averaging 0·00174, and the formula $u(1 - 0·000174t)$, where u depends only on the concentration, serves to express the ratio with an average error of 1 per cent.

The (molecular) conductivity-concentration and fluidity-concentration isothermals are also approximately straight lines, which if produced would intersect the axis of concentration at 10·74N. This would indicate that if the laws observed up to concentration 4N should continue to hold good, the fluidity and molecular-conductivity would disappear at this concentration. The deviations from the linear law are greatest in dilute solutions at 0° C. and 100° C. T. M. L.

2292. *Temperature Coefficients of the Ionic Mobilities in Water with a Law for Univalent Monatomic Ions.* **F. Kohlrausch.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 26. pp. 572–580, May 29, 1902.)—The following table gives the values now adopted for the ionic mobilities l_{18} and their temperature coefficients $\alpha_{18} = \frac{1}{l}\frac{dl}{dt}$ at 18° C. :—

	l_{18}	α_{18}		l_{18}	α_{18}
Li	33·44	0·0265	NH_4	54·4	0·0222
Na	43·55	0·0244	$C_5H_9O_2$	25·7	0·0244
F	46·64	0·0238	$C_2H_3O_2$	35·0	0·0238
Ag	54·02	0·0229	IO_3	33·87	0·0234
K	64·67	0·0217	ClO_3	55·03	0·0215
Cl	65·44	0·0216	NO_3	61·78	0·0295
Tl	66·00	0·0215	OH	174	0·0180
I	66·40	0·0213	½ Zn	45·6	0·0251
Br	67·63	0·0215	½ Mg	46·0	0·0256
Rb	67·6	0·0214	½ Br	56·3	0·0238
Cs	68·2	0·0212	½ Pb	61·5	0·0243
H	318	0·0153	½ SO_4	68·7	0·0227
CNS	56·63	0·0221	½ CO_3	[70]	[0·0270]

In the case of the univalent monatomic ions these constants are related to one another ; if plotted as ordinates and abscissæ the values yield a regular curve which can be expressed by the equation $\alpha = 0·03536 - 0·000329l + 0·0000018l^2$. This equation does not include the value for the hydrogen ion, with a mobility nearly five times as great as that of Cs, but a slightly less accurate equation $(\alpha - 0·0132)(l + 22) = 0·73$ can be used to include the hydrogen value ; it is possible, however, that the highly mobile ions H and OH, which are also the ions of the solvent, should not be included in this law. The law holds good approximately for NH_4 and CNS, but the polyatomic anions $C_5H_9O_2$, $C_2H_3O_2$, IO_3, ClO_3, and NO_3 have smaller temperature coefficients, and the divalent ions, Zn, Mg, Ba, Pb, SO_4, and CO_3 have greater temperature coefficients than those calculated from the equation given above. With rising temperature, the mobilities of the different ions tend to become equal, and the transport value of a salt changes slightly therefore in the direction of the value 0·5. In order to explain the simple relationship between the mobility and its temperature coefficient, it is suggested that the ions are surrounded by a watery "atmosphere," and that the friction is between the solvent water and this atmosphere rather than the simple ion.

T. M. L.

2293. *Polarising Capacity of Palladium.* **M. Wien.** (Ann. d. Physik, 8. 2. pp. 372–387, May, 1902.)—To explain the increase of resistance which takes place in an electrolytic cell through which an alternating current is passed, there is assumed to be a phase-difference between the impressed and the polarisation currents. As regards behaviour, three groups of cells are distinguished, typified respectively by (1) Pt electrodes, (2) unpolarisable electrodes, and (3) platinised Pt electrodes. Warburg's theory for group 2 gives fair results for the polarisation capacity, and has been extended to include groups 2 and 3. An expression is given which sums up his results. In the first of two limiting cases considered, the polarisation capacity is independent of the frequency (group 1). In the second, the phase-difference is constant $\left(=\frac{\pi}{4}\right)$, and the capacity inversely proportional to $\sqrt{}$(frequency). To test the theory better, palladium wires are used along with a more extended range of frequency (64 to 1,024), the method being the same as formerly used (Ann. d. Phys. 4. p. 429, 1901). The wires were sealed in a parallel position in a special glass vessel so that they could be annealed electrically, the vessel being connected with an air-pump; or the vessel could be filled with liquid, the electrolyte used being H_2SO_4 of maximum conductivity. No substantial difference was found to exist between ordinary Pd and Pt, the phase-difference being small, and almost independent of the frequency. But platinised Pt electrodes behaved like smooth ones of greater surface, and Pd electrodes covered with palladium black gave a much higher polarisation capacity and phase-difference than the platinised Pt electrodes. When the palladium black is deposited from a solution to which lead acetate has not been added as was done in the previous cases, it was found, among other things, that it depends on the amount of occluded hydrogen present whether the electrodes approach limiting case 1 or 2. G. E. A.

2294. *Ratio of Distribution of a Base between Two Acids.* **H. M. Dawson** and **F. E. Grant.** (Chem. Soc., Journ. 81. and 82. pp. 512–521, May, 1902.) —Acetic acid is soluble to some extent in chloroform, while tartaric, malic, citric, and succinic acids are not. The sodium salts of none of the above acids are soluble in chloroform. Hence if an aqueous solution containing, say, free acetic and tartaric acids and their sodium salts, be shaken up at a constant temperature with chloroform, and if the distribution ratio of acetic acid between chloroform and water be known as a function of the concentration (from previous experiments), the concentration of the "free" acetic acid in the aqueous solution can be determined, and the distribution of the base between the two acids calculated. The authors determined the disturbing effect due to the presence of the salts and the other acid in the aqueous solution, and found it sufficiently small to be neglected in this preliminary investigation. For the sake of simplicity, the authors explicitly dispense with any introduction of ionisation-coefficients. The values found for the relative avidities of the above-mentioned acids, at a concentration of 0·3 normal, agree very well with the values found by Ostwald, by the volume method, at a concentration of 0·33 normal, but the values obtained by the new method at a concentration of 0·1 normal do not agree with the numbers obtained from Ostwald's experiments on the solubility of calcium oxalate in acids of this concentration. It is pointed out, however, that the relative avidities or strengths obtained by Ostwald in the latter way for a concentration of 0·1 normal can scarcely be reconciled with the corresponding values obtained by the volume method for a concentration of 0·33 normal, since the alteration in the two series of values is too great for such a comparatively small change of concentration. F. G. D.

2295. *Electrical Laboratory Furnace.* **W. C. Heraeus.** (Zeitschr. Elektrochem. 8. pp. 201–203, April 10, 1902.)—A description is given of a new form of electric furnace, consisting of a porcelain tube wrapped round with platinum-foil, which is heated by means of a current. It has several advantages over platinum wire. (1) Contact is more easily obtained between the tube and the heated foil, and therefore the temperature of the tube is more nearly equal to that of the platinum than is the case when wire is used; (2) there is less liability to overheating, and consequent melting of the platinum; (3) decreased cost. The most suitable foil is that of which a square decimeter weighs about 1·5 grams, and of which the thickness is 0·007 mm. If wire is used the weight required is about six times that of the foil. A temperature of 1,500° C. can be obtained, and kept constant, without damage to the furnace. Finally, the oxygen in the tube may be replaced by a continuous current of an indifferent gas. W. C. B.

2296. *Photogalvanography.* **N. Piltschikoff.** (International Physical Congress at Paris, Report, 4. pp. 74–76, 1900–1901.)—If a zinc anode and a solution of zinc have with them a kathode of polished copper slightly oxidised, the zinc is deposited more thickly on the more brightly lit parts of the copper. With sunlight shadows silhouettes can thus be made instantaneously. This leads to suggestions of various practical processes. A. D.

2297. *Harmet Process for the Production of Steel direct from the Ore.* (Electro-Chemist, 2. pp. 93–95, May, 1902.)—In a paper read before the Société de l'Industrie Minérale de Saint-Etienne on April 5, 1902, Harmet deals with the reduction of iron ores in a furnace in which the whole of the necessary heat is electrically generated, the only quantity of coke introduced being that strictly necessary for production of the reducing gases. Ore and flux are fed into a drying or calcining kiln to be freed from water, carbon dioxide, and other volatile materials, and heated to redness by means of blowpipes. The burning gases from the latter pass through the whole mass before escaping to the atmosphere, the red-hot material being forced through low lateral passages by means of a piston into hoppers, and thence to the reducing furnace proper. The coke is heated before being fed into the furnace, the hot mixture of coke, ore, and flux slowly descending into a shaft. To ensure complete reduction before the mixture reaches the hearth, the gases generated by the combustion of the coke are drawn out at the head of the furnace, and forced by a blowing machine through a tube communicating with the base of the furnace, where carbon dioxide, in presence of red-hot coke, is reduced to the monoxide, which besides serving the part of a powerful reducing agent, also acts as a vehicle for the heat electrically produced on the hearth, and not absorbed by the fusion of the iron. Tables are given showing thermic equivalents of two methods of treatment of a given mixture, as well as sketches of the furnace details. [See also Abstract No. 1399 (1902).] O. J. S.

2298. *The Elmore Copper-Depositing Process at Leeds.* (Engineering, 73. pp. 633–634, May 16, 1902.)—This is an illustrated description of the reorganised works of the English Electrometallurgical Company at Hunslet, near Leeds. The original company was established in 1889 to work the Elmore patent for depositing copper on revolving mandrils, a dense deposit being obtained by means of travelling agate burnishers. In 1900 the company and its finances were reorganised, and £200,000 additional capital was put into the business. The depositing plant now consists of 4 × 250 h.p. Bollinckx cross-compound condensing engines with Corliss valves, driving by rope-gearing 4 × 170 kw. Brown-Boveri dynamos yielding continuous current. The mechanical power plant consists of 3 × 400 h.p. Bollinckx engines, driving Brown-Boveri dynamos of equivalent power. The depositing vats are 216 in number, and suffice to deposit 75 tons of copper per week. Agate burnishers are still used, but in some cases the deposited tubes are drawn down after removing from the mandrils. The anodes are cast from Chili bar copper, testing 96 per cent., and these bars are submitted to a preliminary smelting to remove arsenic. A large number of mechanical tests of the deposited copper are given. These vary from 14 to 22¼ tons per sq. in., the highest tensile strength being attained with a sample of a burnished tube annealed and drawn down once before testing. J. B. C. K.

2299. *Electrolytic Treatment of Tin-Scrap by the Lode Process.* **H. Mennicke.** (Zeitschr. Elektrochem. 8. pp. 315–320, May 22; 357–370, June 5; and pp. 381–395, June 12, 1902.)—In this series of articles the author deals with the chemistry and practice of the electrolytic recovery of tin from tin-scrap in a most exhaustive manner. Germany possesses seven works operating processes of this character, and 30,000 tons of tin-scrap are reported to be treated annually. The cuttings and scrap which form the raw material for these recovery works are drawn from England, France, and Switzerland, and the average percentage of tin contained in the scrap does not exceed 3·5. The author discusses the various electrolytes which have been suggested for stripping the tin, and decides in favour of a simple sodium hydrate solution. This electrolyte yields a solution of sodium stannate on passing a current through the cell, and from this solution, tin can be deposited at the kathode in a spongy state, without any risk of contamination by iron. The addition of sodium chloride to the sodium hydrate solution has been suggested by some authorities, but although such addition increases the solvent action at the anode, it is not recommended by the author, since it increases the danger of obtaining an impure deposit of tin at the kathode. The maximum recovery of tin possible by the sodium hydrate process is, according to the author, 88 per cent. A tin recovery works, designed for the annual treatment of 9,000 tons of scrap, would require 60 cells, each of about 3 cubic metres capacity, and each cell when fully charged would contain 150 kg. of scrap, packed in the usual type of lattice-work baskets. The author has carried out a large number of experiments relating to the conditions, as regards current density and temperature, which must be observed in order to obtain the best results with the alkaline process, and full details of these are given in the original articles. J. B. C. K.

REFERENCE.

2300. *Electrolytic Reduction of Aromatic and Fatty Nitrobodies.* **J. Möller.** (Elektrochem. Zeitschr. 8. pp. 239–244, Feb.; 272–275, March; 9. pp. 7–11, April; and pp. 27–35, May, 1902.)—This series of papers gives an account, chiefly from the chemical point of view, of the different known cases of reduction of nitro-compounds, whether in alkaline or acid solutions. The views of Löb, Haber, and Chilesotti on the exact course of the reduction are also given. D. H. J.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

2301. *Engine Requirements for the Parallel Operation of Alternators.* **H. E. Longwell.** (Street Rly. Rev. 12. pp. 358–361, June, 1902. Paper read before the Engine Builders' Association of the United States, at the Annual Meeting held in Pittsburg, Pa., May 22 and 23, 1902.)—In this paper the author starts with the assumption that there will always be a certain amount of irregularity in the engine speed, both cyclical and in successive revolutions, which will necessarily produce some transfer of energy from one alternator to another, and that it is therefore useless in discussing the question of parallel running to assume perfectly uniform speed. The cross currents can never be entirely eliminated; all that can be done is to reduce them as much as possible. It is incorrect to say that bad parallel running is ever due to hunting, or otherwise faulty governors, though these may aggravate the evil; as a fact, the most perfect governor from an engine-builder's point of view is the worst for parallel operation, since the duty imposed on it under these conditions is directly opposed to its natural function. The leading machine tends to take more of the load, and ought therefore, for equilibrium to be restored, to have its steam supply decreased, but the natural tendency of the governor is precisely the opposite. Hence it must be rendered sluggish by dash-pots and similar devices. Referring to the uniformity of angular speed, which is usually considered essential, the author criticises the Westinghouse specification [see Abstract No. 1942 (1902)] on the ground that it is unreasonable to demand the same limit for angular speed variation in all cases, when generators vary so greatly in their electrical characteristics. The short circuit current of some generators is as low as two and a half times the full load current, while that of others may be six times the full load current. With the same maximum flywheel displacement, the cross-currents in the latter case will be much greater than in the former; hence either the allowable displacement is too small in the former case, or it is too much in the latter. The question of synchronising force is next discussed, the assertion being made that in every practical case its effect is to *increase* the irregularity of the angular speed of the engine instead of diminishing it. An instance of this seeming paradox is cited, where by decreasing the terminal pressure of a two-phase alternator by weakening the field the parallel running was greatly improved, so that both phases could be coupled in parallel, whereas with normal excitation it was impossible to parallel on more than one phase. By means of a diagram this result is shown to be what was theoretically to be expected. Starting with the curve of crank effort, approximately sinoidal, a second curve is obtained by integration, the ordinates of which represent the velocity of the crank-pin above and below the mean velocity. This velocity curve is clearly also sinoidal, lagging 90° behind the curve of crank effort. Integrating the velocity curve, a third curve is obtained, the ordinates of which represent displacement in front of or behind the position corresponding to uniform velocity; this curve is also sinoidal, and lags 90° behind the velocity curve, and therefore 180° behind the curve of crank effort. Thus, when this latter is at a maximum and the surplus energy is accelerating the rotating masses, these are always at their maximum displacement *behind* the position corresponding to uniform angular speed, and *vice versâ*. But since the synchronising force due to cross-currents is proportional to the displacement, and tends to accelerate the rotating masses when these are behind the mean position, and to retard them when they are in advance of it, it follows that the synchronising force is acting in unison with the crank-pin effort, and hence tends to increase the displacement. The amount by which this is increased depends to a large extent on the natural oscillation period of the rotating masses. B. P. S.

2302. *Tests of a Sulzer Engine.* **M. Schröter.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 891–896, June 14, 1902.)—This engine was a 1,000-h.p. tandem compound. The diagrams given in the article for the front and back of both cylinders were constructed by taking an arithmetic mean of several indicator diagrams, &c. The steam pressure used was 10·5 kg. per sq. cm. abs. and trials were made with saturated steam at about 180° C., and with superheated steam at about 180 + 100° C. Curves of the relation between cut-off and h.p. show that, with similar conditions, saturated steam produces a somewhat greater gross h.p. The exponents in the formula $PV^n =$ constant are worked out in each case for the compression, and for two stages of the expansion in each cylinder. With saturated steam the "n" for expansion varied from 0·95 to 1·13 (mean about 1), and with superheated steam from 1·0 to 1·9 (mean about 1·3). Reduced indicator diagrams, with theoretical curves added, are given and discussed. In order to allow for leakage past valves and piston, the author made an auxiliary test with Doerfel's method (Z. V. D. I., 1899, p. 601, &c.). The author considers that with such high-class engines it may be assumed that the quantity of steam in the clearance space and at the beginning of the stroke can be deduced with accuracy from indicator diagrams. A large amount of tabulated data is given and discussed. The author has considered the difference in the cooling surfaces and clearances at the different ends of the cylinders, and he deduces from the experiments that the earlier the cut-off the higher the superheat needed to ensure dry steam at the beginning of expansion. Finally, the author works out thermal efficiencies: (1) For the Clausius-Rankine cycle with similar pressures, &c.; (2) for the actual engine with (*a*) feed-water temperature as a basis, (*b*) 0° C. as outlet temperature (see Z. V. D. I., 1899, p. 605, by Doerfel), (*c*) 20° C. as outlet temperature (Mollier). The maximum brake efficiencies which are given, according to (2)*a*, are 0·157 for saturated, and 0·167 for superheated steam. The steam consumption per i.h.p.-hour was 6·2 kg. (mean) with saturated, and 5·24 kg. with superheated steam, including jackets and leakage. R. C. R.

2303. *Schmidt System of Superheating Steam.* (Elect. Engin. 29. pp. 837–839, June 18, 1902.)—The article contains some facts as to recent progress of this system in Britain, gives illustrations of independently fired superheaters, and the full text of a report by Prof. **J. A. Ewing** on trials carried out by him at Erith with a triple expansion engine having a jacketed receiver between the intermediate and low-pressure cylinders, in which the superheated steam on its way to the high-pressure cylinder was used to dry and heat the steam passing to the low-pressure cylinders. The principal data of the trials were as follows :—

Trials.		A	B	C	D	E
Electrical output in kw.		140·2	104 0	67·3	41·2	10·0
Lbs. of steam condensed per hour		2,570	1,940	1,367	1,004	663
Lbs. of steam per kw.-hour		18·3	18·5	20·3	24·4	—
Pressure at stop valve, lbs. per sq. in.		129	130	131	126	82
Temperature at stop valve	C.°	376	371	368	352	295
	F.°	709	700	694	666	583
Temperature of high-pressure steam after receiver	C.°	316	305	298	293	255
	F.°	601	581	568	559	491
Temperature at intermediate cylinder exhaust	C.°	141	128	121	118	118
	F.°	286	263	250	245	245
Mean temperature at l.p. cylinder inlets	C.°	203	193	184	174	159
	F.°	397	380	363	345	318
Vacuum, inches		23·15	23·5	23·8	23·8	22·7
Barometer, inches		29·6	29·6	29·6	29·6	29·6
Indicated h.p.		226	—	—	—	—
Electrical h.p.		188	—	—	—	—
Ratio of electrical to indicated h.p.		0·83	—	—	—	—
Lbs. of steam per i.h.p.-hour		11·4	—	—	—	—

The quantity of steam used per hour in the trials in relation to the electrical output is shown graphically in the following diagram :—

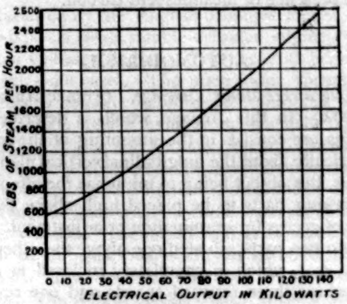


Fig. 1 —Curve of Steam Consumption.

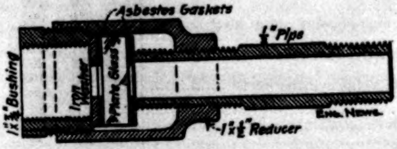
From the curve, the number of lbs. of steam used per electrical unit generated at the various grades of output are thus :—

Kilowatts.	Pounds of Steam used per Electrical Unit.	Kilowatts.	Pounds of Steam used per Electrical Unit.
140	18·3	60	20·8
120	18·5	40	24·5
100	18·7	20	38·0
80	19·4		

With a higher boiler pressure better results would have been obtained, but the steam consumption per kw. is remarkably good. [See also Abstracts Nos. 2303 (1900), 938, 2231 (1901), 150, 1406 (1902).] F. J. R.

GAS AND OIL ENGINES.

2304. *Device for Examining the Interior of Gas-Engine Cylinders while Running.* **W. T. Magruder.** (Eng. News, 47. p. 385, May 15, 1902. Reprinted from "The Gas Engine" for March.)—Into the rear head is screwed a pipe nipple, of say ½-in. iron pipe size, and having a long thread on one end, which is screwed into a 1-in. × 1¼-in. reducer, into the outer end of which is screwed a 1-in. × ¾-in. bushing used as a stuffing-box nut in holding a piece of thick plate-glass in position at the end of the ½-in. nipple. The glass is separated from the nipple, and from the iron washer of the stuffing box, by means of asbestos gaskets. To prevent breakage from overheating, the glass should be several inches from the inner side of the cylinder head, and small enough not to touch the inside of the reducer. With this apparatus, the construction of which is shown in the accompanying diagram, the blue flame characteristic of complete combustion can easily be distinguished from the yellow flame that indicates the presence of incandescent carbon. G. W. DE T.



AUTOMOBILISM.[1]

2305. *Chenard-Walcker Motor Carriage.* (France Automobile, 7. pp. 232–235, April 12, 1902.)—In this carriage, which is described in detail in the article, the main feature consists in the mounting of the motor and transmission gear symmetrically about the longitudinal vertical plane midway between the pairs of wheels, the object being to minimise the effects of vibration and to enable the working parts to be placed high above the ground so as to render them easy of access for examination or adjustment. The transmission shaft is divided into two parts, situated one above the other and connected by the change-speed gear, which is completely enclosed in an oil bath. This gearing is arranged for three forward speeds and one reverse speed, and is designed so as to minimise flexure of the shaft as much as possible in effecting the speed changes. The front portion of the transmission shaft is coupled to the motor flywheel by means of a spring friction clutch coupling, which may be disengaged by means of a foot lever. The rear part of the shaft is articulated and drives, through bevel gear, a live axle, supported above the rear axle, which is fixed. This live axle transmits power to the hubs of the rear wheels by means of spur gear. The article is illustrated by views of the various working parts of the vehicle. J. G.

2306. *Ader Light Automobile.* **L. Fournier.** (Locomotion Automobile, 9. pp. 230–233, April 10, 1902.)—This article deals with the 8-h.p. type of Ader vehicle constructed by the Société Industrielle des Téléphones. The motor is of the four-cycle type, and has two cylinders arranged at an angle to each other, in a vertical plane. Power is transmitted from the motor through change speed and bevel gear to a countershaft, from which the rear axle is driven by means of a chain transmission. Two brakes are fitted—one, a foot-operated brake, being applied to the rear axle and working on pulleys attached to the differential gear, and the other, a hand-operated brake, having action upon the front axle. The brake-controlling gear is arranged so that when the brakes are brought into action the supply of explosive charge to the motor cylinders is simultaneously reduced. The chief feature of note in this vehicle is the vapouriser, which is an adaptation of the old wick type hitherto little used. It consists of a chamber in which the oil supplied is maintained at a constant level by means of a float-controlled valve. A number of wicks dipping into the oil are suspended from the top of the chamber, which is removable, and carburation is effected by the aspiration of air through the wicks. The vapour formed is supplied to a mixing valve, where a further supply of air is added to form the explosive mixture for the motor cylinder. Lighting back from the cylinder through the mixing valve is prevented by means of wire gauze screens placed across the outlet from the mixing valve. The discharge from the motor cylinders takes place through an exhaust silencer consisting of four concentric tubes enclosed in a chamber, the gases passing successively through the tubes before escaping to atmosphere. The article is accompanied by illustrations of the mechanism. J. G.

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[1] Electric Automobiles are described in the Section dealing with Electric Traction.

2307. *Daimler Cars.* (Automotor Journal, 7. pp. 357–360, July 20, and pp. 384–387, Aug. 2, 1902.)—A complete description is given of the "1902" types of cars manufactured by the English Daimler Motor Company. The chief types are a 9-h.p. car with double-cylinder engine, and 12-h.p. and 22-h.p. cars with four-cylinder engines. The general arrangement of the mechanism is identical in all cases. The main frame, sprung from the axles on semi-elliptic springs, is constructed of wood reinforced with steel plates. A subsidiary frame of angle steel is hung from the main frame towards its front end, and carries the engine and friction clutch. The shaft carrying the male portion of the clutch is coupled to the lower shaft of the change-speed gear by an adjustable coupling, and motion is transmitted to the upper gear shaft by one of four sets of spur-wheels, which correspond to three forward speeds and one reverse speed. The differential cross-shaft, which is in front of the main portion of the gear-box, is driven by bevel gearing from the upper spur-wheel shaft. The final transmission is by independent chains to the rear road wheels. The weight of the chains in the 9 and 12-h.p. cars is from 14 to 15 cwt., and about 22 cwt. in the 22-h.p. car. In the 9-h.p. engine the cylinders are 105 mm. bore × 100 mm. stroke, both pistons being coupled to a single crank pin on a shaft in which the engine flywheels form the crank webs. The 12-h.p. engine has cylinders 86 mm. bore × 100 mm. stroke, and the normal speed is 930 r.p.m.; and the 22-h.p. engine cylinders are 105 mm. bore × 130 mm. stroke, normal speed 720 r.p.m. Both these engines have external flywheels. C. R. D'E.

2308. *Barton's Airship.* (Engineer, 93. p. 392, April 18, 1902.)—Its largest diameter is about $\frac{2}{5}$ from the front end, it is 180 ft. long and 41 ft. diameter, capacity 156,000 cubic ft.; this gives a lifting capacity of 10,080 lbs. The upper surface is enveloped in a chemise provided with cane stiffeners, from which the car is suspended. The ship is propelled by six two-bladed triple fans. Each pair of fans will be driven by an oil motor, exerting 45 b.h.p. Mr. Alexander's experiments at Bath show that a thrust of 25 lbs. per b.h.p. can be obtained.

In this instance the thrust is taken as 20, giving a total of 2,700 lbs. for the six fans. There are three sets of aeroplanes, each set consisting of three, one over the other, each aeroplane having a rod in front for the pivot and a rod in the rear for raising and lowering the end by links. The deck remains horizontal by means of water-tanks at each end, each contains 50 gallons of water which is kept, by means of a pump and connecting pipes, in a constant state of circulation. A pendulum-operated valve is arranged so that should one end of the deck drop, the pendulum shuts off the water from the lower end and pumps it to the upper tank till the level of the deck is restored.

	lbs.
Envelope with chemise and attachments	1,900
Subsidiary balloon	140
Five men	800
Motor spirit 216 gallons	1,460
Six 17-ft. fans	500
Three 45-b.h.p. engines	1,150
Deck, superstructure, and aeroplanes	3,500
Instruments, goods, clothing, and sundries	150
Total	9,600

The area of the balloon is 1,320 sq. ft. According to Rouse and Smeaton, the air-resistance of a flat surface at 13 miles per hour is just under 1 lb. per sq. ft. Langley showed that this amount is excessive. The pressure is reduced if the object is in the form of a cone, and the resistance is variously given as from one-third to one-fifth of a flat surface. Therefore the resistance is under 700 lbs. The thrust available is 2,700 lbs., and we may expect a speed exceeding 20 miles per hour. M. O'G.

REFERENCES.

2309. *Rocking Valves and Valve Gears.* **H. F. Schmidt.** (Amer. Electn. 14. pp. 265–277, June, 1902.)—The author considers the principal types of valves and valve gears employed in modern steam-engine practice, together with the reasons for the modifications of the original Corliss type of valve and gear. The paper is accompanied by sixty-two diagrams and other illustrations. G. W. DE T.

2310. *Oil as Fuel.* (Street Rly. Rev. 12. pp. 322–325, June, 1902.)—Contains data of tests from New Orleans, Mobile, and El Paso. [See Abstracts Nos. 950, 1766 and 1944 (1902).] F. J. R.

2311. *Steam-raising from London Refuse.* (Elect. Rev. 50. pp. 929–930, June 6, 1902.)—The paper gives results of a seven hours' test of Meldrum's "Simplex" destructors with steam boilers, as regards raising steam from London refuse. [See also Abstracts Nos. 1138, 1726, and 2330 (1900), 204 and 2288 (1901), and 761 and 949 (1902).] F. J. R.

2312. *Gas Engines for Central Stations.* **C. H. Williams.** (West. Electn. 30. p. 427, June 14, 1902. Abstract of a paper read before the National Electric Light Association at Cincinnati, Ohio, May 22, 1902.)—The author reviews the advantages of gas engines [passing lightly over their disadvantages], and suggests possibilities of utilising part of the heat carried away in the cooling water. H. R. C.

GENERAL ELECTRICAL ENGINEERING.

2313. *Small Accumulator Charging Device.* (Motorwagen, 5. pp. 105–106, April 15, 1902.)—This article describes an arrangement for charging small accumulators, such as those employed for ignition purposes on automobiles. It consists of a permanent magnet dynamo, the shaft of which is vertical and coupled to the arms of a small reaction turbine. These arms rotate inside of an aluminium ring against the interior of which the discharged water impinges. The whole turbine is enclosed in a glass case fitted with inlet and delivery water connections.

The following table gives the dimensions and output of the three types built by the designers (Roth and Benninghoven).

Type.	Capacity (Watts).	Water Consumption (Litres per hour).	Turbine Ring Dia. in mm.	Turbine Ring Height in mm.
I............	4	200	150	70
II............	2	100	95	60
III............	1	50	50	40

J. G.

2314. *Mordey-Fricker Meter.* (Electrician, 49. pp. 131–133, May 16, 1902.)—The meter consists of a clock deprived of its hair-spring, and carrying on its balance-wheel shaft a disc of slate, on which a few pieces of iron wire are fixed in the manner of a compass card. This disc is surrounded by a fixed coil of wire conveying the current to be metered. The disc acts as a variable hair-spring; the iron which it carries is magnetised more or less strongly by the current, a directive force being exerted in an opposite sense to that acting on a galvanometer needle—that is to say, tending to bring the iron needle to an axial position in the coil. This action, in conjunction with the ordinary action of the driving spring of the clock, causes the disc to oscillate at a rate directly proportional to the current. The meter does not go at all when no current is passing, for there being then no directive action on the iron, the disc comes to rest at one or the other extreme of its arc of oscillation. The balance-wheel shaft rests on a footstep jewel, but to avoid risk of injury to this in carriage, the greater part of the weight is taken off it by a silk fibre suspension. The meter has a range of from 1 to about 15, and is primarily intended for small installations, say up to 30 lamps, where, if 15 lamps is the maximum load, the meter will record with one lamp. It is also applicable to motor installations, the no-load current being sufficient to start the meter. The meter can be used on direct or alternating currents, and curves of the constant are given for both currents. In the alternate-current meter the error is nil from 0·6 to 2·4 amperes, 5 per cent. at 0·3, and 1·5 per cent. at 2·6 amperes. The curve for direct current is rather different, the error being nil at 0·3, 1·4 and 2·3 amperes. G. H. B.

2315. *Starting Resistances.* **A. E. Gott.** (Inst. Elect. Engin., Journ. 31. pp. 1220–1230; Discussion, pp. 1230–1233, June, 1902.) (Abstract.)—The author considers the construction of motor-starting switches, deals with various types of starters, and criticises the methods on which their designs are based. The early switches were apt to throw serious strains on the motor and the starter, and in modern designs there was still room for considerable improvement. The resistance of the steps should be divided so as to limit the increase between steps to a definite amount, the general rule being stated by the formula $a \times f^n =$ total resistance, where $a =$ armature resistance; $f =$ common factor; and $n =$ number of sections of resistance. In practice, however, this needed modifying to $f^n = R/9, f = \sqrt{(R/9)}$, in order to meet the conditions of manufacture, these latter calling for numerous alterations in design. For high voltages, the sparking between contacts could be reduced by limiting the p.d. to a predetermined amount, and when this figure did not exceed 80 to 85 volts the sparking became inappreciable. The contacts might also be placed as close as $\frac{1}{16}$ in. asunder, and even when the switch was moved backwards to re-insert resistance, the arc could not be maintained across the gap. The barrel type of controller was considered the worst in use, as the diameter of the barrel was limited to about 6 in., and the steps were correspondingly reduced between off and full on. Geometrical division of the sections was not possible, as, although the current increment could be equalised, the high voltage on the first contacts caused serious burning. A compromise could be made by reducing the current increment on the first steps (and consequently the voltage) and increasing both at the armature end. Liquid resistances, when carefully designed, afforded the most perfect method of control, particularly with reversing motors. Certain difficulties, however, existed, which might be overcome by enamelling the pot half-way down and arranging the dipping-plate to pass between two other plates cast into the sides of the pot. The enamel compelled the current to pass through a greater length of solution at starting, and gave much better control. Resistances of this type were in constant use on voltages up to 500 with every satisfaction.

W. E. W.

2316. *Selector Switch.* (Electrician, 49. pp. 133–134, May 16, 1902.)—The switch is primarily intended for switching on or off arc-lighting circuits. Each arc-light circuit is provided with a switch apparatus, these being connected in series by a circuit including a transmitter in the station. The transmitter has a number of pairs of contact discs on a spindle, which is turned through one revolution on winding up a spring by a lever. Each pair of discs corresponds with one of the automatic switches, and this is operated by moving a pair of contact fingers to the disc in question and working the lever. The contact disc in rotating sends a number of current impulses; for a 10-switch apparatus, there are 22 in one direction and 7 in the reverse direction. The moments at which the reverse impulses are sent differ for each switch, and only that switch is operated to which the particular series of impulses sent corresponds.

The automatic switches have each a selector, consisting of a polarised electromagnet, which for, say positive currents, moves a disc round by means of a ratchet, one tooth at every impulse; the disc is moved against a spring, and is held by a detent. When a negative current is sent, the detent is lifted, and if the switch is not the one for which the particular series of impulses is intended, the disc returns to its original position. If, however, it be the corresponding switch, another detent engages in a notch in a plate fixed to the disc, and holds the disc in position. The result of the 22 positive impulses is to rotate the disc of the corresponding switch, and that of no other, through a half-turn. At the half-turn a ratchet fixed to the disc engages in a snail on a barrel of fibre carrying a contact piece, and this turns with the disc, when a final negative impulse releases the latter. The contact piece in turning makes contact with a spring finger and completes the circuit of an automatic switch. At Croydon, where the system is now working, current is taken from the station battery for the selector circuit, and from the private lighting network for the automatic switches. G. H. B.

2317. *Safety Devices for Protecting Insulated Conductors against Excessive Electric Pressures.* **G. Benischke.** (Elektrotechn. Zeitschr. 23. pp. 552–555; Discussion, p. 555, June 19, 1902. Paper read before the Elektrotechn. Verein, March 25, 1902.)—The author first discusses how excessive pressures may be produced, and explains the effects which take place in the secondary of a transformer when the circuit is broken at times corresponding to different points on the current curve of the primary circuit; also the effect in switching in and out transformers and motors, &c. The apparatus described includes several arrangements similar to that referred to in Abstract No. 395 (1902), further details being given of the water resistances employed. Another form of safety-device, suitable for use on low-pressure mains, is made in the form of a screw-plug cut-out, in which there is an air-gap between two metal surfaces separated by a sheet of mica 0·2 mm. thick, having a hole in it. This arrangement allows a spark to pass to earth when the pressure exceeds 600 volts. In the discussion, **Wilkens** stated that similar safety devices to those first mentioned had been used with metal resistances immersed in oil, but these had fused in some cases. C. K. F.

REFERENCES.

2318. *Wattmeters and Counters for Alternate Currents.* **H. Armagnat.** (Écl. Électr. 31. pp. 237–245, May 17, 1902.)—The paper consists of a *résumé* of recent patents. G. W. DE T.

2319. *Electrical Engineering in Europe and America.* **J. Denham.** (Inst. Elect. Engin., Journ. 31. pp. 824–832, April, 1902. Paper read before the Capetown Section, Dec. 2, 1901.)—A general account of a tour undertaken by the author through England, Germany, and America. W. H. S.

2320. *Possibilities and Limitations of Electric Pumping.* **L. A. Hicks.** (Journal of Electricity, S. F. 11. pp. 216–219; 222–223; and Discussion, pp. 223–224, 1901. Paper submitted for Discussion at the Fifth Annual Convention of the Pacific Coast Electric Transmission Association, San Jose, Cal., June, 1901.) A. H. A.

2321. *Electricity in Cotton Mills.* **W. B. S. Whaley.** (Amer. Soc. Mech. Engin., Trans. 23. No. 951. pp. 769–780; Discussion, pp. 781–790, 1902.) W. H. S.

2322. *Connections of Switchgears for Electric Light and Power Purposes.* **W. E. Warrilow.** (Feilden, 6. pp. 438–447, May, and pp. 531–543, June, 1902.) G. W. DE T

2323. *Electrically Operated Air Compressors.* (Eng. and Mining Journ. 73. p. 733, May 24, 1902.)—The paper contains an illustrated description of the electrically driven air compressors, ranging in capacity from 7½ to 1,000 cubic ft. of free air per minute, manufactured by the Christensen Engineering Company. G. W. DE T.

2324. *Electricity in Mining.* **G. H. Gibson.** (Eng. and Mining Journ. 73. pp. 307–309, March 1, 1902.)—The paper refers briefly to a number of American mines where electrical machinery has recently been introduced. G. W. DE T.

GENERATORS, MOTORS, AND TRANSFORMERS.

2325. *Standardising Electrical Machinery.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 705–721, May, 1902.)—This is a revision, "in view of such suggestions and extensions as experience and practice have since indicated to be desirable," of the 1897 report of the Standardisation Committee. It opens with a number of preliminary definitions, and then proceeds to the consideration, in detail, of the methods to be adopted in specifying and measuring the efficiency of electrical apparatus and equipment, classified under the following sections: Commutating Machines, Synchronous Machines, Synchronous Commutating Machines, Rectifying Machines, Stationary Induction Apparatus, Rotary Induction Apparatus, Transmission Lines. The permissible limits of temperature rise are next considered, referred to the standard conditions of a room-temperature of 25° C., a barometric pressure of 760 mm., and normal conditions of ventilation—that is, the apparatus under test should neither be exposed to draught nor enclosed, except where expressly specified. The minimum temperature limits fixed are as follows: For the fields and armatures of commutating, rectifying, and synchronous machines, 50° C., to be measured by resistance; for commutator and collector rings and brushes, 55° C., by thermometer; for the electric circuits of rotary induction machines, 50° C., by resistance; for squirrel-cage or short-circuited armatures, 55° C., by thermometer; for the electric circuits of continuous-service transformers and for reactors, induction, and magneto-regulators, 50° C., by resistance; for bearings, and for all parts not specified, 40° C., by thermometer. In any case, when the thermometric determination gives a higher value than the resistance measurement, the former is to be taken. In testing railway motors a rise of 75° C. is allowed after one hour's continuous run at 500 volts, on a stand, with the motor covers removed. Higher temperatures than those specified are allowed in cases where the insulation is of a specially heat-resisting character. It is recommended that high dielectric strength should be specified in preference to high insulation, bearing in mind the fact that the latter can be largely increased by baking, to the detriment of the former. The conditions of testing for dielectric strength for machine insulation, including the testing voltages for the various values of the rated terminal voltages, are very fully specified. The lowest testing voltage is 1,000 volts, for rated terminal voltages not exceeding 400 volts. From 2,500 to 10,000 rated voltage the testing voltage is double. From this to 20,000 volts rated, an excess of 10,000 volts is to be employed; and after 20,000 the testing voltage is to be 50 per cent. in excess of the normal. Regulation and its determination, and methods of rating receive detailed consideration. The standard voltages recommended are: For direct-current low-pressure generators, 125, 250, and 550 to 600 volts; for low-pressure circuits, direct or alternating, 110 and 220 volts; for alternating-current primary distributing circuits, an average e.m.f. of 2,200 volts; for high-pressure circuits, 6,000, 10,000, 15,000, 20,000, 30,000, and 60,000 volts. The standard frequencies suggested are 25, 60, and 120 to 140. The overload capacities recommended are: For generators, 25 per cent. for two hours; for motors, other than railway motors, and motors for intermittent service, 25 per cent. for two hours, and 50 per cent. for one minute; for synchronous converters, 50 per cent. for half an hour; for transformers, 25 per cent. for two hours. Recommendations are also made with regard to photometric measurements. G. W. DE T.

2326. *Single-phase Alternators on Polyphase Circuits.* **C. O. Mailloux.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 611–621, May, 1902.)—The author describes an experiment made at Phœnix, Arizona, in which two steam-driven, single-phase alternators were run in parallel with a three-phase long-distance transmission line by means of a Scott two–three-phase transformer. A three-phase rotary converter was also on the circuit, and it was found that the three-phase generators could be switched out, the single-phase machines being held to their proper phase relation by the reactions of the converter. As soon as it was switched out they fell out of step. A. E. L.

2327. *Asynchronous Motors.* **H. S. Meyer.** (Écl. Électr. 31. pp. 423–428, June, 21, 1902.)—In this paper the author draws a comparison between induction motors of the squirrel-cage type and those having a starting resistance in the rotor circuits. He advocates the use of squirrel-cage rotors in all cases except where it is necessary to start on a heavy load with a comparatively small current. His reasons for thus recommending the squirrel-cage rotor are: (1) Simplicity of construction; (2) No rubbing contacts; (3) Great simplicity of operation; (4) The independence of the rotor of the number of stator poles. Also, the power-factor is higher because the self-induction of the rotor is a minimum, the distribution of the current in the rotor is uniform, the magnetising current is usually small on account of the low induction density in the rotor, the efficiency is high on account of the idle copper being a minimum, air friction is small, and the friction of brushes does not exist. To prove these statements, the author experimented with a three-phase motor of 7·5 h.p. at 220 volts with rotor wound first as a squirrel-cage and afterwards with collecting rings and external resistances. The results are given in the following table:—

	As Squirrel-cage Motor.	As Motor with Resistance in Rotor.
Hysteresis loss	250 watts	250 watts
Copper losses (Stator)	320 „	320 „
Friction losses	125 „	270 „
Copper losses (Rotor)	310 „	285 „
Efficiency on full load	84·9	88·2
Efficiency on half load	84·1	80·6
Power-factor on full load	89	88
Power-factor on half load	77	75·6
Maximum useful power developed	15·5 h.p.	14 h.p.
Starting couples	6·7 kg.	4·5 kg.
Starting current	114 amperes	26 amperes
Weight of copper in rotor	6 kg.	12·6 kg.

W. G. R.

2328. *Asynchronous Generators for Single- and Poly-phase Currents.* **A. Heyland.** (Elektrotechn. Zeitschr. 23. pp. 560–567, June 26, 1902. Paper read before the 10. Jahresversammlung des Verbandes Deutsch. Elektrotechniker in Düsseldorf.)—The author describes in detail the theory and constructional features of these machines, showing the latest improvements achieved. The machines are classed in two categories, varying slightly from each other, according to the different purposes for which they are intended. They have the advantage over the ordinary synchronous generators that they can easily run in parallel, and are quite reliable for power transmission, acting with accuracy over large ranges of load fluctuations. They can also be regulated to maintain a constant voltage, whether the load is free from induction or not. Acting as motors, they maintain $\cos\phi = 1$ for all loads, which is a decided improvement over the ordinary synchronous motors, where $\cos\phi$ becomes unity only for adjusted loads. The paper is fully illustrated. L. G.

REFERENCES.

2329. *Armature Windings.* **F. Eichberg.** (Zeitschr. Elektrotechn., Wien, 20. pp. 209–212, April 27, 1902.) The author applies a graphical method to the study of armature windings, with special reference to multiple wave windings. A. H.

2330. *Graphical Representation of Armature Windings.* **F. Eichberg.** (Elektrotechn. Zeitschr. 23. pp. 355–356, April 17, 1902.)—Referring to Arnold's paper [see Abstract No. 1433 (1902)], and the "reduced" winding diagram therein described, the author expresses the opinion that a still simpler mode of representation consists in making use of a "potential diagram," of which he gives several examples [see also preceding Reference]. A. H.

2331. *Magnetic Leakage in Dynamos.* **Corsepius.** (Elektrotechn. Zeitschr. 23. pp. 395–396; Discussion, p. 396, May 1, 1902. Paper read before the Dresden Elektrotechnischer Verein, March 20, 1902.)—Some general remarks on magnetic leakage, and the analogy between a leaky electric and a magnetic circuit. A. H.

2332. *Determination of Regulating Resistances for Shunt-wound Machines.* **R. Krause.** (Elektrotechn. Zeitschr. 23. pp. 383–384, May 1, 1902.)—The author considers a graphical method for determining the number of steps and value of each step in a regulating resistance for a shunt-wound dynamo. A. H.

2333. *Graphical Determination of Starting Torque and Slip of Induction Motors in Relation to the Rotor Resistance.* **E. Berckenbrinck.** (Zeitschr. Elektrotechn., Wien, 20. pp. 245–246, May 18, 1902.)—The author solves this problem by the aid of Heyland's diagram, and applies the solution to the determination of the starting resistances required to obtain a given torque, and to regulate the speed of the motor. A. H.

2334. *Pressure Regulation by Synchronous Converters.* **M. Seidner.** (Elect. World and Engineer, 39. pp. 761–763, May 3, and pp. 814–815, May 10, 1902.)—The author discusses, by the use of graphical methods, the effects on pressure regulation produced by varying phase displacements of p.d. and current in the case of rotary converters connected to the far end of a long transmission line. A. H.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

2335. *Roof Insulation of* 15,000-*Volt Lines.* (Journal of Electricity, S. F. 12. p. 89, May, 1902.)—A method is described of taking high-pressure line wires into and out of station buildings. It was devised by E. A. Beck, and, after a thoroughly satisfactory trial of two years, is being generally adopted for high-pressure work by the San Gabriel Electric Company. The conductor is encased in 1,500-volt solid rubber insulation, over which is drawn soft rubber hose, and over this again ¾-in. garden hose. Round this is a porcelain bushing 18 in. long and ½ in. thick. This is embedded in sulphur cemented into a second porcelain bushing 8 in. long and ¾ in. thick. The insulated conductor is then passed up through a glass insulator with the cap knocked off, and finally taped and painted. The insulator is screwed down over the hose until the 18-in. bushing enters the inner petticoat, when the two are sulphured together. G. W. DE T.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

2336. *Electrically Operated Plant on the North Sea Canal.* (Engineering, 73. pp. 33–35, Jan. 10 ; 105–107, Jan. 24 ; 170–172, Feb. 7 ; 243–245, Feb. 21 ; and pp. 271–274, Feb. 28, 1902.)—A full description of the North Sea Canal, the Ymuiden Locks, and the Port of Amsterdam is given, including a detailed and illustrated account of the electrically driven machinery employed for working the gates and sluices of the locks. The installation, which was the first of its kind, was carried out by the Haarlem Engine Works. The locks are provided with twelve gate-leaves, the largest of which weigh 140 tons each, and are 49·2 ft. high by 77·5 ft. wide ; there are twelve chambers within the lock walls, each containing the machinery for operating one gate-leaf and one sluice, and two chambers, each containing the machinery for one capstan.

To open a gate within 80 seconds against a water-head of 4 in. requires 45 h.p. Each gate-leaf is operated by one series-wound motor, running at 360 r.p.m., in a watertight compartment. The motor drives chain-sheaves through worm-gear and double-helical gear-wheels, with a safety friction device ; the chains are endless, and pull to and fro a four-wheeled carriage, which operates the gate-leaf through an iron boom. The sluices are operated through similar gear by motors, each of 17 h.p., running at 270 r.p.m. Safety devices to prevent damage to the motors in the event of the gates or sluices jamming, or by over-winding, are provided. The capstans are driven by motors, each of 21 h.p., at 270 r.p.m. through toothed and bevel gearing. In case of emergency all the apparatus can be worked by hand ; the gates and sluices can also be operated by means of the capstans.

A full description of the complicated switch-gear is given. All the operations are controlled from six switch pillars on the pier-heads, the reversing switches, which are fixed in the chambers with the machinery, being operated through pilot motors. The apparatus in each switch pillar consists of two simple throw-over switches, with a "current interrupter" in the base of the pillar. The power and lighting plant consists of two 75-kw. generating sets, and two engines driving smaller dynamos, together with a storage battery; light is supplied on the three-wire, and power on the two-wire system, at 350 volts. There are twelve 10-ampere arc lamps and five hundred glow lamps. The cables are all underground or under water; the former are lead-sheathed, the latter lead-sheathed and heavily armoured. At the Port of Amsterdam there are seven electric cranes, and a number of hydraulic cranes, driven by electric pumps, with a power-station containing two 75-kw. sets for power supply, and two 30-kw. lighting sets. A. H. A.

2337. *The Fayet-Chamonix Electric Railway.* (Engineering, 73. p. 573, May 2, 1902.)—This is a 3 ft. 3⅜ in. gauge line, 10·8 miles long. The sharpest curves are 490 ft. in radius; and of the two steepest gradients, one is 9 in 100 over 1·35 miles, and the other is 8 in 100 over 0·85 mile. A third rail is employed for supplying current. At the gradients, a central rail is fixed between the track rails, on which a special shoe-brake acts, limiting the speed of descent to 6·25 miles an hour. The rails weigh 69 lbs. per yard, and the track rails are in 39-ft. lengths, held on fifteen sleepers by means of sole-plates and ordinary wood screws. Angle fishplates are used for joining the lengths of both track and brake rails. The contact rails rest on creosoted wood blocks. To prevent sliding action of the track down the gradients, a layer of concrete has been placed at intervals of 320 ft., in which old rails have been embedded; these act as abutments to the sleepers. There are two generating stations, one near Selvos and the other near Chavants, both being turbine-driven from affluents of the river Arve. The former contains four 325-h.p. central discharge turbines, revolving on horizontal shafts. The first 140 ft. of the fall are utilised for the head of water. Four 200-kw., six-pole, continuous-current dynamos are connected to the turbines by elastic insulated couplings. The turbines are placed above the tail-race, have suction pipes, work under a head of 124 ft., and develope 320 h.p. at 470 r.p.m. A 60-h.p. outflow turbine, running at 520 r.p.m., drives two 40-kw. exciters, which are also used to light the station. The second station contains two similar turbine-driven dynamos and exciter, but the head of water is here 308 ft. Each train consists of four or five cars with a luggage van, and represents a dead load of 120 tons, for about 170 passengers. The heavy gradients made it necessary that each car should be provided with motors, and that they should be controlled by one driver only, from the head of the train. The controller is worked by compressed air, and operates the electric controllers on each car. A train of five cars, at a speed of 7·45 miles an hour, absorbs on the up gradient of 9 in 100, 800 amperes at 550 volts. Starting on the same gradient absorbs about 11,000 amperes. G. W. DE T.

2338. *Syracuse Street Railway.* (Street Rly. Journ. 19. pp. 323–331, May, 1902.)—The power-station is near the centre of the system, on the Erie Canal. It contains (1) two 1,250-h.p. compound Reynolds-Corliss engines, running at 80 r.p.m., and each direct connected to an 800-kw., 12-pole, direct-current generator; (2) three 500-h.p. vertical engines, running at 400 r.p.m., each belted to three G.E. 4-mp., 300-kw. generators; (3) a vertical compound engine of 1,000 h.p. running at 125 r.p.m., and direct-connected to a G.E. 10-pole, 500-kw., direct-current generator. There are six 250-h.p. Stirling boilers, two 300-h.p. Aultman-Taylor boilers, and one 500-h.p. Abendroth and Root boiler. There are two Snow duplex feed-pumps, each

12 in. × 6 in. × 10 in., and a Wheeler feed-water heater. The steam loop with the Holly gravity return system is used on the boilers. The steam pressure of the plant is 160 lbs. A gravity oiling system is employed, the requisite pressure being obtained from a storage tank on the roof. Compressed air at a pressure of 80 lbs., supplied by a steam air pump, is used for cleaning the dynamos, in place of dusting. The erection of a cooling tower is contemplated, as the feed-water is extremely bad. At present, Lagonda mechanical boiler-tube cleaners are in regular use for the removal of scale. One of these cleaners has gone through a 4-in. tube 20 ft. long, plugged full of scale, in seven minutes. A specially designed hydraulic hoist is employed for removing wheels or trucks from the cars, and has been found capable of changing a pair of wheels in twenty-eight minutes. Each car has four G.E.-54 motors. Christensen air-brakes are employed. Each car carries forty-four passengers. The track is ballasted almost entirely with stone, and the rails are laid on ties 6 in. × 8 in. × 8 ft. Within the city, the rails are partly grooved and partly plain tram-head, weighing 90 lbs. per yd. The guard rails weigh 117 lbs. per yd. The overhead work is partly side-pole and partly span. G. W. DE T.

2339. *Houghton County Street Railway.* **W. R. Parker.** (Street Rly. Journ. 19 pp. 336-341, May, 1902.)—The power-house contains five horizontal return tubular boilers, each 72 in. in diameter, and containing 112 3-in. × 16-ft. tubes, and working at a pressure of 150 lbs. The shells and heads are of open-hearth steel, having a tensile strength of 55,000–65,000 lbs., a minimum elastic limit of 33,000 lbs., and an elongation in 8 in. of not less than 25 p.c. There are two duplex boiler feed-pumps and a Wainwright even-flow supplementary feed-water heater. The high-pressure steam-pipes are of lap-welded steel, flanged when over 2¼ in.; the low-pressure ones of lap-welded iron, flanged when over 4 in. There are two units, one for railway work and one for supplying power to the three-phase transmission line. The former consists of a 750-h.p. horizontal cross-compound condensing Corliss engine, direct-connected to a Westinghouse 10-pole, 500-kw., 550-volt railway generator running at 90 r.p.m. The working pressure is 125 lbs. At full load, and with a vacuum of 25 in. at the exhaust, the steam consumption is guaranteed not to exceed 15 lbs. per i.h.p. per hour. The full-load generator efficiency is 94 p.c., and it is guaranteed to stand a 50-p.c. overload for one hour and 75 p.c. temporarily. The transmission unit consists of a 750-h.p. horizontal cross-compound condensing engine with gridiron valves, having a cut-off varying from zero to ¾-stroke, direct-connected to a Westinghouse three-phase, 25 ∿, 500-kw., separately excited generator running at 100 r.p.m. The engine is guaranteed to stand a 50-p.c. overload for two hours. Each of the engines has a reheating receiver between the cylinders. The steam consumption of the second engine at full load, and with a vacuum of 26 in. at the exhaust, is guaranteed not to exceed 14 lbs. per i.h.p. per hour.

The generator has a revolving armature, and is guaranteed to develope 500 kw. continuously at 380 volts with an efficiency of 94 p.c., and 750 kw. for two hours with an efficiency of 94·5 p.c. The full-load current is 750 amperes per phase. The regulation of the generator is within 8 p.c. when the power-factor is 100 p.c., and the speed constant. For continuous running with a power-factor of 90 to 100 p.c. the temperature rise is guaranteed not to exceed 40° C. above a room temperature of 25° C. A jet condenser with vertical cross-compound air pump is employed. A

250-kw., three-phase, 25 ∿, Westinghouse synchronous converter, rated at 420 amperes at 600 volts on the direct-current side, is located in the engine-room. It is self-exciting when driven from the alternating-current side, and when driven from the direct-current side is separately excited. This and the substation converters have a full-load efficiency of 93 p.c., and are designed to stand an overload of 50 p.c. for two hours. The temperature rise is guaranteed not to exceed 40° C. above a room temperature of 25° C. on a continuous run.

There are six 100-kw., Westinghouse oil-cooled, 380–11,000-volt, three-phase transformers, having a full load efficiency of 96·7 p.c. and a voltage regulation of 2·2 p.c. when the power-factor is 100 p.c. One side of the substation contains six 100-kw., 11,000–380-volt transformers, and on the other side are two 250-kw., three-phase, rotary converters, delivering current to the feeders at 600 volts. The transmission line, some 12 miles long, is supported on the railway poles with triple petticoat insulators guaranteed for a working pressure of 15,000 volts. The 30 and 60-lb. T-rails, of A.S.C.E. section, are laid on cedar ties 2 ft. apart. The overhead construction is of the top-guy flexible bracket type strung with No. 00 trolley wire. 35-ft. cedar poles are used with an 8-in. top, and carry three cross-arms for the transmission and feed wires. The larger cars, which carry 40 passengers, are provided with four 38-h.p. G.E. motors, and four smaller cars are provided with two similar motors. Air brakes are employed. G. W. de T.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

2340. *Train Resistance.* **W. J. Davis, Jr.** (Street Rly. Journ. 19. pp. 360–362; Discussion, pp. 362–367, May, and pp. 460–461, June, 1902.)—The author, in view of the present tendency towards high speed, calls attention to the importance of obtaining a rational formula for train resistance in place of the empirical ones now in use. The items to be considered are, according to him: (1) journal friction, taken as independent of speed; (2) rail friction, assumed to vary as the speed; (3) wind resistance, varying as the square of the speed, with the cross-section and end shape of the car, and with the number of cars forming a train. He writes down such a formula in the most general form, and determines the constants from tests made by him on a train composed of a locomotive, baggage car, and three standard passenger coaches of the Erie Railroad, weighing on an average 26 tons each without load. The train was quickly brought up to maximum speed, when the power was thrown off and the train allowed to coast. Curves were obtained showing the variation of speed with time and with distance, with the locomotive alone, and with it and one, two, three, and four cars respectively. Examples of these curves are given. The formula so obtained is—

$$f = 4 + 0{\cdot}13V + 0{\cdot}004AV^2\{1 + 0{\cdot}1(n - 1)\}/T_1$$

in which f = friction in lbs. per ton; V = velocity in miles per hour; T = weight of train in tons; A = cross-section of car in sq. ft., including trucks, motors, &c.; n = number of cars, including locomotive. The cross-section A comprises the section of the car body proper plus the section bounded by the car wheels, the underside of the car body, and a horizontal line, tangent to the head of the rails, and normal thereto. *Discussion.*—**J. Lundie** criticises the method employed in obtaining the formula. He considers that important items are omitted by the author, *e.g.*, the lack of perfect resilience in the parts, both of the track and rolling stock, which are under strain. He proposes a formula, which, in addition to minor modifications, substitutes the first power of the speed for the square. **S. T. Dodd** insists on the importance of obtaining more extended data, and points out discrepancies in the results given by the author's formula with those obtained in the Berlin-Zossen trials. **L. Bell** also comments on these discrepancies and distrusts the coasting method employed in the tests. **H. V. Wille** compares the author's formula with that employed at the Baldwin Locomotive Works, and finds a fairly close agreement. **The Author,** in replying to the various criticisms, maintains his conclusions, and quotes a number of experimental results tending to support them. He admits, however, the great importance of further and exhaustive tests, especially on high street cars vestibuled at the end. He states that the General Electric Company of America is now making arrangements to conduct a series of such tests up to the highest speeds within the capacity of the track and equipment available for the purpose. G. W. DE T.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

2341. *Heating of Railway Motors.* **A. H. Armstrong.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 569–592, May, 1902.)—In this paper the author attempts to outline a method of determining the probable heating and energy consumption of a given motor equipment for any class of work. He also considers very fully the possibility of arriving at some concise method of rating railway motors of such a character as to indicate with accuracy their comparative service capacity under different conditions. He has, however, been unable to devise any commercially practicable method of rating railway motors superior to the one-hour test now generally employed for this purpose. The question of the heating of motors being very closely connected with that of train resistance, he bases his calculations on the results of the tests made by W. J. Davis, Jr. [see preceding Abstract]. A large number of curves based upon the foregoing data, together with measurements taken by recording instruments, of voltage, amperes, and speed upon a time basis, are given in the paper.

The author observes that the study of these curves appears to indicate that, so far as motor heating is concerned, it is preferable to use the largest gear ratio and highest rate of acceleration possible for the accomplishment of the service contemplated, providing the maximum speeds are low, but that practically any rational rate of acceleration may be used with speeds approaching 60 miles an hour. In the choice of gear ratio for a given service, the line fluctuations, station load and energy input must be considered, as well as the motor heating with different rates of acceleration. The curves show that the possible schedule speed for a given gear ratio is controlled by the number of stops per mile, but the heating of the equipment and the proper weight of the car are found to be the same over a very wide range of schedules and stops. It is important that the equipment should be geared for the lowest possible maximum speed that will permit the maintenance of the schedule in question, as a gear ratio giving too high a maximum speed, not only overheats the motors, but produces needless demands upon the generating and distributing systems. Owing to the decreased wind resistance per car as the number of cars in a train increases, the operation of high-speed single-cars is disadvantageous from a pure energy standpoint, but frequency of service often creates traffic, and may therefore warrant the extra expenditure for coal. Another very important point is that longer trains at greater intervals increase the fluctuation at the feeding-point. The size of the rotary converters must therefore be somewhat increased, and in all probability a larger amount of feeder copper will be required to keep the drop within the same limits. G. W. DE T.

2342. *Electro-Pneumatic Railway System.* **B. J. Arnold.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 659–662, May, 1902.)—This paper gives a preliminary account of a system of electric traction, upon the designing of which he has been engaged for a considerable time, and which is to be tried on a 60-mile length of railway, of which 20 miles are now nearly completed. The system consists essentially in the use of a single-phase (or polyphase if desired) alternate-current motor in which both the rotor and the stator, or portion which usually remains fixed, are made capable of rotation, and each is connected with an air-compressing engine and storage reservoir. This motor is designed for the average power required, and runs continuously at constant speed and constant load, and, therefore, at maximum efficiency. When the car is at rest, the stator runs at what is known as synchronous speed, which depends only on the rate of alternation of the current, and compresses air into the storage reservoir. To start the car, the air-compressor connected with the rotor is throttled, diminishing the speed of the stator. This causes the rotor to turn in the opposite direction, since the mutual action of the stator and rotor keeps the relative speed constantly at the speed of synchronism. By increasing the throttling, the speed of the rotor will be increased until it attains the speed of synchronism, when the stator will be at rest. If a still higher speed is desired, the stator is turned in the same direction as the rotor, by admitting air from the storage reservoir to the engine in connection with the former. If a higher starting effort is required than the motor can exert, then the rotor is turned by the admission of air to the engine in connection with it. This arrangement enables a car to ascend an incline at any desired speed up to the maximum, and with the motor working at its highest efficiency and imparting its full power to the car. In descending, the motor may, as desired, either utilise the full power derived from the line, or may be used to compress air with the stored energy of the train, thereby acting as a brake. In case of the supply of current being cut off for any reason, the car can be run for a considerable distance by means of the store of compressed air, and the author points out that this feature will enable a car to work on a high-pressure trolley wire over private right-of-way, and allow the trolley wire to be dispensed with, if necessary, when this ceases, so that a car can pass through a town on any line of rails, whether electrically equipped or not, until it reaches the outskirts, when it can be again connected to the trolley wire. This feature will also be of value in switching work, for each car, being independent, can leave the main-line track, and operate over switches or sidings, without complicating the yards with additional overhead or third-rail conductors, thus necessitating trolley-line conductors over the main-line track only. If a single-phase motor is used, only one overhead or third-rail conductor is required, and only one of the track rails need be used for the return, so that the other one may be left free for an automatic signal system if desired. The current can be taken into the car at any pressure up to the limit of the insulation (15,000 volts is to be used on the line now in course of construction), and led to the motor through a static transformer to effect its reduction to any desired value. The power-station will always work at practically constant load, which will greatly reduce the requisite size of the plant and conductors. All the controlling operations are mechanical, no alteration being made in the electrical circuits, and all the operations being affected by means of the controlling lever of the motor-man, as in the systems now in use. G. W. DE T.

2343. *Comparative Acceleration Tests with Steam Locomotive and Electric Motor Cars.* **B. J. Arnold** and **W. B. Potter.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 593–610, May, 1902.)—These tests were made principally for the purpose of comparing steam and electric traction for short distance suburban service. A number of the curves obtained are given in the paper. They clearly demonstrate that during acceleration the electric motors utilise the weight upon their drivers more effectively than a steam locomotive. The electric motor, owing to its being able to maintain the maximum acceleration for a longer period, enables the same distance to be covered in the same time with a smaller expenditure of energy. Assuming that coal for a power-station may be purchased for 80 per cent. of the cost of that used in the locomotives, and that the cost of coal for electrical power is about one-third of the total cost, including maintenance and interest, the authors consider it probable that the actual gross cost of electrical power would, in this class of service, closely approximate to that of the coal consumption of the steam locomotive. Maintenance and attendance would be much in favour of electric power.
G. W. DE T.

2344. *Relative Cost of Steam and Electric Railway Operation.* **B. J. Arnold.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 623–657, May, 1902.)—The author was commissioned, in August, 1901, by the New York Central Railroad Company, to study the conditions governing the operation of its trains between Mott Haven Junction and Grand Central Station, and to report upon the feasibility of operating them electrically. This division consists of 5·3 miles of quadruple track, of which 2 miles are underground, and it was the annoyance caused to passengers, due to the use of steam locomotives in the tunnel, which led the company to examine into the advisability of adopting electric power. A most elaborate series of investigations was carried out by means of a dynamometer test-car inserted between the locomotives and trains run on each section of the road under ordinary service conditions, and from the results of these, and a very complete analysis of the traffic conditions, it was found that the electrical energy required to haul a ton 1 mile over the division under the existing conditions would average 63 watt-hours. No less than twelve alternative systems of electric power distribution were then examined in detail. Some of the least costly of these had to be rejected, owing to their requiring the location of power-stations in positions where their erection would probably have been prohibited by the City authorities. The system ultimately recommended was one with a combined alternate and continuous-current power-station near one end of the division, with a sub-station near the other end, with batteries in both stations. The alternate current was to be transmitted at a voltage of 11,000, and the continuous current at a voltage of 600. With this system it was found that, on the assumption that the electric locomotives would be operated by the same number of men at the same wages as those required for the steam locomotives, the total costs per locomotive-mile came out at 24·18 cents for steam and 28·63 cents for electricity. With regard to these figures, the author of the paper observes that they could be made more favourable to electricity, were an optimistic view of many of its advantages taken, and that it was probable that in practice the gain would actually be greater. He preferred, however, to maintain a conservative view throughout the investigation, but considered it safe to conclude that the saving in working expenses by the electric system would be sufficient to offset the increased fixed charges due to the additional investment made necessary by its adoption. The constituents of the total cost were made up as follows :—

	Steam.	Electricity.
Operating expenses per locomotive-mile, exclusive of fixed charges, but including water, labour, cost of cleaning and repairing tunnel, and all other expenses of locomotive operation	23·05	15·80
Fixed changes per locomotive-mile, assuming that it now requires 40 locomotives to perform the present service, and that 33 electric locomotives could perform the same service	1·13	7·83
Total in cents	24·18	23·63

If the multiple unit system were adopted, as it would be if the electrification were extended over the rest of the line, or if the forward guard or brakeman were allowed to take the place of the second man while passing through the tunnel and yards, where two motor-men in charge of each locomotive were considered advisable, a saving in wages would be added to the foregoing. G. W. DE T.

2345. *Determination of Grades and Alignment.* (Railroad Gazette, 34. pp. 323–324, May 2, 1902. Extract from the report of the Committee on Roadways of the American Railway Engineering and Maintenance of Way Association).—In considering the question of grade with reference to economy, it is not always the grade which limits the weight or length of a train, as the limiting grade is a virtual grade which may be different from the actual one, due to a difference in velocity at the top and bottom. When the surplus energy stored in a train is drawn upon to allow of less tractive effort than would be necessary if uniform speed were maintained, we have a momentum grade. The practical problem for the engineer is to determine either (*a*) how far a steep actual grade can be continued, and yet allow a required virtual grade to be maintained, or, where an actual grade is under consideration, to determine (*b*) what the virtual grade will be under prescribed conditions of operating, and also to find (*c*) the speed which it is possible to acquire at the foot of a momentum grade. The points are dealt with at length in the report, and an interesting series of diagrams accompanies the text. C. E. A.

ELECTRIC LAMPS AND LIGHTING.

2346. *Methods of Illumination.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 456–472, April, 1902.) (Discussion.)—This is a report of the discussion which took place on several papers dealing with the question of illumination. These were by Bell [see Abstract No. 1260 (1902)], Ryan [see Abstract No. 800 (1902)], Howell [see Abstract No. 1017 (1902)], Hewitt [see Abstract No. 799 (1902)], and Sharp [see Abstracts Nos. 665 and 666 (1902)]. In the discussion, **J. W. Howell** said that the filament of a Nernst lamp has only $\frac{6}{10}$ of the amount of surface that carbon has at the same efficiency in watts per candle.

This shows that the lamp is run at a very high temperature, and that the colour of the light is not due to any selective radiation. The projected surface of black carbon at 3 watts per candle is about 0·00325 sq. in. per candle; at the same efficiency the projected surface of grey carbon is 0·00225 sq. in., and of the Nernst lamp 0·00125 sq. in. **J. W. Lieb** said that the standards of candle-power now used in America are derived from certain standards imported from the Reichsanstalt ten years ago. A comparison was recently instituted between the Reichsanstalt standard, which is the Hefner amyl-acetate lamp, and the present American standards; and it was found that the two now differ by rather less than 2 per cent. **S. E. Doane** said that in the Bunsen photometer, the absorption of light in the grease-spot depends in part on the colour of the light, and that a three-watt lamp, compared with a four-watt lamp, would give a greater candle-power than the photometer indicates. **L. Bell** said there was some selective radiation in the case of thoria; but the only substances which have a notable selective radiation are erbia and the oxides of one or two of the rare metals which are allied with the cerium and didymium group. **T. J. Johnston** said that no flame dependent on the atmosphere for its oxygen can make a satisfactory standard of light. When carbonic acid gas or sulphurous acid gas is mixed with the air supplied to the illuminant, the candle-power is reduced in almost exact proportion to the adulteration. On the other hand, 1 per cent. of carbonic acid gas mixed with the illuminant produces a reduction of from 10 to 12 per cent. in the candle-power. W. H. S.

2347. *Arc Lighting.* **C. M. Green.** (Canad. Elect. News, 12. pp. 136–139, July, 1902.)—The author gives several characteristic curves relating to arc lamps, showing the relation between volts and amperes in an open and enclosed arc, and in an enclosed arc run with a resistance in series, and also the relation between volts and length of arc in a 5-ampere enclosed lamp. He deals also with the points necessary to ensure stability in running, and advocates the use of enclosed lamps, worked by direct constant current, if possible. There is need for a rectifier for transforming three-phase, 25-cycle constant potential current into direct constant current for series arc lighting, the rectifier to cost less and have a higher efficiency than the motor-generator sets now employed. The Buffalo General Electric Company have at present 3,500 open arc lamps; current is supplied by twenty-six arc machines, each rated at 6,250 volts, 9·6 amperes, and driven at 500 r.p.m. by synchronous motors from Niagara. These machines are now to be rewound for 8,500 volts and 6·6 amperes, and the enclosed lamp will be adopted. Alternators and constant-current transformers would have cost twice as much as the rewinding process, and the line losses in the distributors would have been greater, seeing that 7·5 amperes would have been required in an alternate-current lamp. Boston has used the series direct-current enclosed arc system since 1898. They now have 6,000 lamps, driven by fifty arc generators, giving 8,500 volts and 6·6 amperes. W. H. S.

REFERENCES.

2348. *Electric Distribution in Paris.* **C. Marquet.** (Génie Civil, 40. pp. 346–349, March 22; 359–362, March 29; 377–380, April 5; 395–397, April 12; and pp. 410–413, April 19, 1902.)—This is a comprehensive series of papers dealing with the distribution of electric light and power in Paris, mainly from the financial standpoint, with short descriptions of the various central stations. [See also Abstract No. 2505 (1900).] G. W. de T.

2349. *City of Mexico Transmission System.* **S. Q. Hayes.** (Elect. World and Engineer, 39. pp. 465–471, March 15 ; 503–507, March 22 ; and pp. 545–548, March 29, 1902.)—These papers give a very full description, with diagrams and other illustrations, of the system dealt with in Abstract No. 595 (1902). G. W. DE T.

2350. *Niagara Falls Power Transmission Plant.* **H. W. Buck.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 531–546, May, 1902.)—The paper deals with details of the new generator, the exciter plant, the main switchboard, and the methods of interconnecting the American and Canadian power systems. [See also Abstracts Nos. 412 and 1629 (1902).] G. W. DE T.

2351. *High-Speed Railways.* **F. B. Behr.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 486–493, April 5 ; 517–519 ; and Discussion, pp. 519–523, April 12, 1902. Paper read before the Berlin Bezirks-verein.)—The paper advocates the "Mono-rail" system for high-speed work, and gives some illustrations of the Listowel-Ballybunion line, and sectional drawings and details of the "Mono-rail" line near Brussels, and of the projected one between Manchester and Liverpool. The signalling system proposed for the latter is also fully described, with sectional drawings. [See also Abstract No. 1440 (1901).] G. W. DE T.

2352. *Electric Traction.* **J. C. Robinson.** (Soc. Arts, Journ. 50. pp. 408–421 ; Discussion, 421–424, March 21, 1902.)—The paper deals with the development, present condition, and probable future expansion of electric tramways and tube railways, mainly from the economical and legislative points of view. G. W. DE T.

2353. *Block Signals on Heavy Electric Railroads.* (Street Rly. Journ. 19. pp. 255–262, April, 1902.)—The paper is supplementary to one by H. S. Knowlton [see Abstract No. 2489 (1901)], and gives a detailed description, with sectional drawings, of the apparatus employed on the elevated railways in Boston and Chicago.
G. W. DE T.

2354. *Street Railway Wheel Sections.* (Street Rly. Journ. 19. pp. 265–267, April, 1902.)—The paper consists of a series of dimension drawings and descriptions of wheel sections taken from a number of sources and illustrating a great variety of forms now in use. G. W. DE T.

2355. *Analysis of Street Railway Operations in Germany.* **W. Mattersdorff.** (Street Rly. Journ. 19. pp. 291–295, April, 1902.)—This is an abstract by the author of a paper in the *Zeitschrift für Kleinbahnen*, and contains numerous curves and tables dealing with the costs, traffic density, and other operating conditions of a number of German tramways. G. W. DE T.

2356. *Insulation of Trolley Wires.* **J. B. Pomey.** (Écl. Électr. 31. pp. 5–7, April 5, 1902.)—The author gives a mathematical solution of certain particular cases where difficulties are encountered in fault-testing by the voltmeter method.
M. O'G.

TELEGRAPHY AND TELEPHONY.

2357. *Automatic Relay Translation for Long Submarine Cables.* **S. G. Brown.** (Inst. Elect. Engin., Journ. 31. pp. 1060–1075; Discussion, pp. 1075–1085, June, 1902.)—With very feeble currents, "butt" contacts in a relay will not work, since the resistance of such a contact may be many thousands of ohms; while, if the local battery is increased so as to break down this resistance, the contact coheres. The author finds that the revolving contact pieces proposed by Varley in 1862 do not remedy the difficulty; he himself prefers to press the end of the relay tongue upon the surface of a divided plate. If this plate is caused to move, sensitiveness and good contact are secured. Following up this idea, the author causes the relay tongue to bear upon the surface of a rotary drum, the latter being divided into insulated sections, and the sections joined to P.O. or other relays. The movement of the recorder-coil by means of two silk or quartz fibres joined to its shoulders, and to the frame carrying the tongue, causes the extremity of the tongue to move over the drum in a comparatively large arc. The tongue consists of a fine siphon tube carrying a bronze wire tipped with iridium. The drum revolves about 150 times in a minute. The relay depends for its efficiency upon the reduction of frictional resistance to the lateral movements of the tongue, due to tangential motion of the surface. If the drum is stopped, the tongue also stops moving, the cable currents being too feeble to overcome the statical friction between tongue and surface. A condenser of 2 m.f. is used in circuit with each half of the drum, and the tongue end is found to

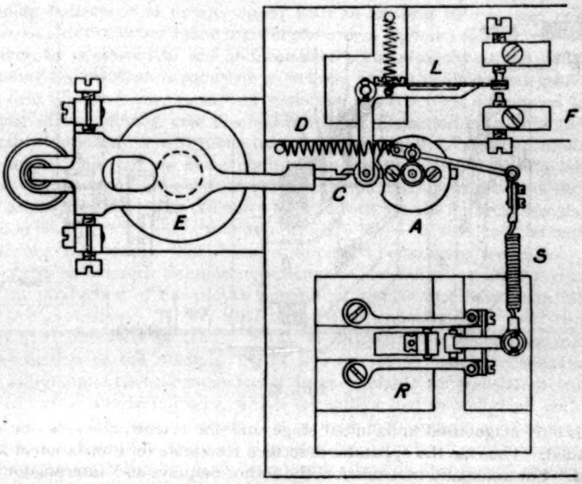

Fig. 1.

improve the contact. There is a receiving condenser, as usual, to curb signals and exclude earth currents. The "Variable Zero" due to the accumulation of charge in this condenser has to be dealt with. The author and A. L. Dearlove had found that this could be got rid of by a high resistance shunt across the receiving and transmitting condensers, but that with such an arrangement earth currents made themselves perceptible. The author prefers "Local Correction," which he applies as follows: A current from a local battery and the recording relays is sent through a circuit having considerable retardation, made up of a condenser placed between two high resistances, all capable of minute adjustment. The arrangement is such that, by a separate winding on the suspended coil, the correction current compensates for the gradual dying away of the cable current. An inductive shunt is also used across the terminal of the suspended coil, of 80 ohms resistance, for steadying and curbing the latter, and so increasing speed. The shunt has many thousand turns of copper wire and a heavy closed magnetic circuit. It is found that, with the feeble currents from the cable, the iron is only magnetised in its initial stage, and the retentiveness may be disregarded. Thus far, the apparatus described is suitable for translation at key-speed. For automatic transmission, the author employs an "interpolator" to reproduce the signals which are dropped at high speed when successive impulses of the same sign occur. It should run in approximate synchronism with the transmitter. It has two sets of signalling levers, similar, but mechanically distinct. Fig. 1 shows the half which transmits the "dots." The electromagnet E is worked from one of the ordinary relays which are in circuit with the drum relay. The lowering of the armature removes the catch C from the clutch-sleeve A, which revolves, and moves the lever L putting battery to line. A crank-pin on A also revolves, and by means of a spring S, rocks the reverser R to which the battery is connected, and this, at stated times in the revolution, reverses the battery, which acts as a curb to the first battery current, or cutting off the battery, and putting the line to earth, acts as "plain" automatic. Thus a long contact at the drum relay, due to the running together of two or more dots, is split up by the "Interpolator" into its component parts, and

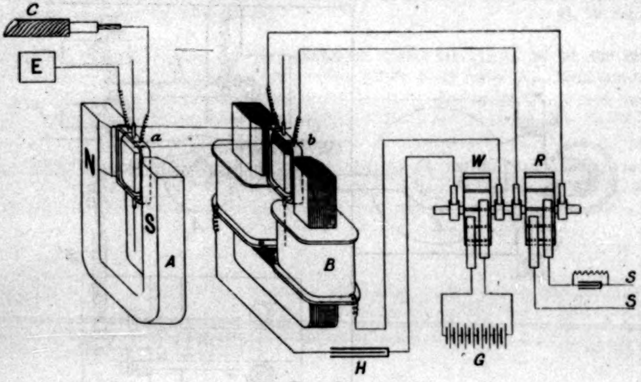

FIG. 2.

retransmitted as such. In place of the "interpolator," an "automatic perforator" may be employed. In this case there are three instead of two clutches, which operate punches, by means of cams, for perforating the tape. With this tape, other instruments can be fed with the least delay. Slight failures in the relay must necessarily be at once detected, consequently there are two local registers, one showing the drum and tongue contacts, the other the signals actually sent into the second cable. The author exhibits actual tapes showing the recorder trace for the drum relay, single and duplex, and the rectification of the signals by the interpolator. Finally, the "magnifying relay," the forerunner of the "drum cable relay," is described. Fig. 2 explains its arrangement. Field coils B are the seat of an alternating current. When the coil *b* is moved, there is an induced current from the field. This is rectified by R, and can then work a siphon recorder or other instrument by leads *ss*. By plugging in capacity, the period of the coil is increased, and by using induction, the period is reduced. Thus a ready means of adjustment is available. The instrument promises to be very useful for amplifying cable signals, and tapes were exhibited in illustration of this fact. It will permit of a reduced sending battery, or of greater speed with an existing battery, and possibly allow of a direct writer being used in place of a siphon recorder. It might, further, be employed to test and compare a complex circuit, the deflection showing the resultant capacity or induction; for, if the alternating current in the field is of sine-wave form, and induction or capacity is introduced in the circuit of the moving coil, the rectifier being dispensed with, and the coil suitably adjusted, it will move one way for induction and the other for capacity. This line of investigation was suggested by H. A. Taylor and A. L. Dearlove. *Discussion.*—**Ayrton** thought the apparatus was the first successful solution of the difficulty of transforming the blurred signals of a siphon recorder in a long cable into ordinary Morse signals, and the mode of restoring the waves that have disappeared extremely ingenious. The synchronism between the sending instrument and the interpolator is essential for the production of the proper number of ripples that have been blurred out in transmission. **H. W. Sullivan** did not consider that "butt" contacts were so troublesome as stated. **H. D. Wilkinson** was of opinion that the reproduction of the missing ripples was not of so much consequence as the utilisation of the extremely feeble force available for translation and the control of a wandering zero, which the author had so well dealt with. In reply, **S. G. Brown** remarked that at very high speeds synchronism was automatic. Vibration had been suggested for the relay tongue instead of the sliding contact, but it had been found, with vibration, that the contact was not long enough, and that the film of oxide on the surfaces did not always disappear when a hammer contact was made, and this might be a considerable obstacle. This last is an objection to "butt" contacts. The use of the "interpolator" on long cables is not indispensable. E. O. W.

2358. *Wireless Telegraphy.* **M. Ascoli.** (Elettricista, Rome, 11. pp. 142–148, June, 1902.)—A transmitter may be tuned to any one of a number of receivers by keeping the induction coil going and bringing an iron core to a definite position within it. Slight movements of the core will make the required signals, which will only make a continuous line, instead of dots and dashes, in an untuned spy receiver. A. D.

2359. *Multiplexing the Telegraphone.* (Elect. World and Engineer, 39. p. 911, May 24, 1902.)—P. O. Pederson has recently patented a method of using the Poulsen telegraphone in such a way as to record a number of messages on a single steel strip, and to reproduce each message without interference from the others, enabling a long speech or a number of signals to be stored upon a comparatively short strip. The invention consists essentially in the use of two or more recording magnets, the connections of which are varied for each message with the corresponding variation in the combined action of the magnets on the recording strip. To reproduce any given message, the connections of the magnets must be adjusted to the same combination that was used in impressing it. [See also Abstract No. 476 (1901).] G. W. DE T.

REFERENCES.

2360. *Speed of Transmission on Submarine Telegraph Cables.* **Devaux-Charbonnel.** (Écl. Électr. 31. pp. 124–133, April 26; and pp. 170–177, May 3, 1902.)—The author investigates mathematically the problem of predetermining the speed of transmission in the design of submarine cables, and verifies his conclusions by comparison with the results obtained in working various existing cables. G. W. DE T.

2361. *Long-distance Telegraph Cables.* **J. H. West.** (Elektrotechn. Zeitschr. 23. pp. 430–431, May 15, 1902.)—In connection with inter-town communication, as the wires increase in number it becomes increasingly difficult to send messages free from disturbance. The author compares overhead and underground cables, showing how considerations of capacity and inductance enter into the question. He then gives sketches of various suggested cables, having paper or other insulating material, which he considers preferable to present forms. P. E. S.

2362. *Wireless Telegraphy in Spain.* **E. Guarini.** (Electrician, 48. pp. 1006–1009, April 18, 1902.)—The author describes the transmitting and receiving apparatus used by Cervera in his 1901 experiments between Ceuta and Algeciras. G. W. DE T.